Upper Lillooet Hydro Project

Operational Environmental Monitoring Year 3

Prepared for:

Upper Lillooet River Power Limited Partnership,
Boulder Creek Power Limited Partnership,
888 Dunsmuir Street, Suite 1100
Vancouver, BC ,V6C 3K4

April 29, 2021

Prepared by:

Ecofish Research Ltd.

Published by Ecofish Research Ltd., 600 Comox Rd., Courtenay, B.C., V9N 3P6

For inquiries contact: Technical Lead documentcontrol@ecofishresearch.com 250-334-3042

Citation:

Faulkner, F., M. Thornton, O. Fitzpatrick, S. Braig, T. Jensma, K. Ganshorn, V. Dimma, A. Newbury, and H. Regehr. 2021. Upper Lillooet Hydro Project Operational Environmental Monitoring: Year 3. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership by Ecofish Research Ltd., April 29, 2021.

Certification: *stamped version on file*

Senior Reviewer:

Sean Faulkner, M.Sc., R.P. Bio. No. 2242

Fisheries Biologist/Project Manager

Technical Leads:

Heidi Regehr, Ph.D., R.P. Bio. No. 2386

Wildlife Biologist

Sean Faulkner, M.Sc., R.P. Bio. No. 2242

Fisheries Biologist/Project Manager

Kevin Ganshorn, M.Sc., R.P. Bio. No. 2448

Biologist, Project Manager

Disclaimer:

EXECUTIVE SUMMARY

Ecofish Research Ltd. (Ecofish) was retained by the Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership (collectively, the Partnerships) to conduct year three of the operational environmental monitoring program (OEMP) for the Upper Lillooet Hydro Project (ULHP) (the Project). The Project is comprised of two hydroelectric facilities (HEF), the largest of which is located on the mainstem of the Upper Lillooet River (Watershed Code (WC): 119). The other facility is located on Boulder Creek (WC: 119-848100).

The OEMP addresses the operational monitoring conditions identified during the environmental assessments (Lewis *et al.* 2012, Leigh-Spencer *et al.* 2012, Hedberg and Associates 2011, Lacroix *et al.* 2011a, b, c, d, NHC 2011) and conditions listed in Schedule B of the Environmental Assessment Certificate (EAC) E13-01 (EAO 2013). The aquatic components of the OEMP are also based on the *Fisheries and Oceans Canada (DFO) Long-term Aquatic Monitoring Protocols for New and Upgraded Hydroelectric Projects* (Lewis *et al.* 2013a). This report documents the field work and analysis conducted following Year 3 of the OEMP (Harwood *et al.* 2017).

Aquatic and Riparian Habitat

Riparian Revegetation Assessment

The objective of riparian revegetation effectiveness monitoring is to evaluate whether efforts to revegetate temporarily cleared riparian areas meet the performance measures prescribed in the OEMP (Harwood *et al.* 2017). The performance measures (80% survival of planted stock, tree density at or above 1,200 stems/ha, and shrub density at or above 2,000 stems/ha) were based on the DFO and MELP (1998) revegetation guidelines, as recommended by the Long-term Aquatic Monitoring Protocols for New and Upgraded Hydroelectric Projects (Lewis *et al.* 2013a). Riparian vegetation restoration monitoring also contributed to Coastal Tailed Frog (*Ascaphus truei*) habitat compliance monitoring at disturbed riparian areas along the Coastal Tailed Frog tributary crossed by the Upper Lillooet River (ULR) Hydroelectric Facility (HEF) penstock. Revegetation monitoring is occurring in Years 1, 3, and 5 of operations.

Twelve permanent revegetation monitoring plots ("plots") were assessed on September 1 and 2, 2020 to evaluate the effectiveness of revegetation efforts. Plot locations were selected to provide a representative sample of site conditions of riparian revegetation areas associated with three infrastructure components for the ULR HEF (intake, penstock, and powerhouse) and one (the powerhouse) for the Boulder Creek HEF. In Year 3 of the five-year monitoring program, average estimated tree and shrub stem densities (12,333 tree stems/ha (± 8,148) and 4,883 shrub stems/ha (± 1,504)) from all permanent revegetation monitoring plots combined met the density targets of 1,200 tree stems/ha and 2,000 shrub stems/ha. There was substantial variability in tree and shrub stem density among plots; however, the target for trees was met in all plots, and the target for shrubs was met at all except one plot. Furthermore, densities increased at all plots except one (ULL-PRM09). Six tree and eleven shrub species were documented within the plots. Average percent vegetation cover was 24%, and although this was below the target of 80%, cover had increased in all vegetation areas except one (ULL-PRM09) since Year 1 monitoring took place. Bull thistle (*Cirsium vulgare*) was removed at ULL-PRM08 and ULL-PRM06. Overall, the results indicate that woody vegetation is establishing, vegetation cover is increasing, and revegetation is progressing well.

Additional years of natural regeneration are likely to contribute to the rehabilitation of the riparian revegetation areas. However, to enhance and accelerate the condition of specific revegetation areas to meet the OEMP targets by the last year of planned monitoring (Year 5), the following actions are recommended for the next monitoring year, scheduled for 2022.

2022 Monitoring Recommendations:

- Continue monitoring revegetation according to the OEMP.
- Continue to survey for invasive species and plan and implement control treatments as necessary.

Water Temperature and Air Temperature

The objective of monitoring water temperature is to determine Project effects on stream temperature and assess whether project-related effects are biologically significant and affect growth, survival, or reproductive success of Upper Lillooet River and Boulder Creek fish populations. To achieve this, water temperature will be monitored continuously for the first five years of operation and compared to the baseline data using a Before-After-Control-Impact (BACI) design following completion of the monitoring program. Temperature metrics include daily and monthly temperature, length of the growing season, number of extreme temperature days, rate of temperature change, and mean weekly maximum temperature (MWMxT). These metrics are compared to BC Water Quality Guidelines (BC WQG, MOE 2019) to assess potential impacts on aquatic life and on fish species present in the Project area.

The baseline thermal regime in the Upper Lillooet River and Boulder Creek was characterized between 2008 and 2013 using water temperature data from two monitoring sites in each watercourse: one upstream control site and one impact site located in the lower diversion reach, where the lower diversion site is assumed to be representative of baseline conditions immediately downstream of each Project. Baseline air temperature was characterized in the Upper Lillooet River and Boulder Creek from 2010 to 2013 at locations adjacent to the water temperature sites.

Operational monitoring for both facilities began in March 2018 and includes two new locations for each facility: one at the tailrace and one downstream of the tailrace. In addition, a site was established in North Creek (NTH-USWQ1) for the purpose of replacing Boulder Creek upstream baseline data that were compromised by groundwater inflow during the late fall to early spring period, following at least one year of concurrent water temperature monitoring. The current operational record for both facilities spans until October 2020, and five years of operational data collection is ongoing.

Baseline and operational results indicate that Upper Lillooet River and Boulder Creek are cold-water streams, where daily-average temperatures <1°C occur during the winter and daily average summer temperatures are consistently well below 18°C. During baseline monitoring the monthly average water temperatures of all sites in the Upper Lillooet River ranged from 0°C to 7.3°C. During operational monitoring, the monthly average water temperatures ranged from 0.8°C to 7.6°C. In Boulder Creek, the monthly average water temperature of all sites during baseline ranged from 0.5°C to 7.9°C and, during operational monitoring, the monthly average water temperatures ranged from 0.6°C to 8.8°C.

The length of the growing season in the Upper Lillooet River during baseline monitoring ranged from 644-degree days to 861-degree days at the upstream site and was 825 degree days at the diversion site. During operations, the growing season ranged from 746 to 839 degree days at the upstream sites, from 922 to 1,121 degree days at the diversion and downstream sites. The longest growing season occurred in the diversion reach during operations in 2019.

The length of the growing season in Boulder Creek during baseline ranged from 367-degree days at the upstream site to 898-degree days in the diversion. During operations, the length of the growing season in Boulder Creek ranged from 644-degree days at the upstream site to 1,185-degree days at the diversion site, with the longest growing season recorded in 2019 in the diversion reach.

We recommend that the monitoring program continue in 2021 (Year 4), based on the methodologies and schedule prescribed in the Project OEMP (Harwood *et al.* 2017). We recommend that water temperature data continue to be collected in the upstream reach of Boulder Creek (BDR-USWQ2) and North Creek (NTH-USWQ1) to provide concurrent data sets to determine a relationship between water temperatures in the two creeks. It is also recommended that the current upstream site in the Upper Lillooet River (ULL-USWQ03) be retained at its existing location for the remainder of operational monitoring.

This report marks the third year of water temperature monitoring. A detailed BACI analysis will be completed following the collection of five full years of data to provide an assessment of potential Project effects on water temperature in the Upper Lillooet River and Boulder Creek.

Frazil Ice

A protocol was established in December 2017 to monitor frazil ice conditions in the Upper Lillooet River and Boulder Creek diversion reaches and its potential effect on the availability of fish habitat. The protocol involves an automatic alarm system that is triggered when five consecutive days of -5ºC or lower mean daily air temperatures are forecasted at the Pemberton Airport and/or Callaghan Valley stations. If these cold temperatures persist for three consecutive days after an alarm has been triggered, an Ecofish Qualified Professional (QP) notifies the operators and requests photographs of the diversion reach at established photo monitoring points. If the photographs suggest frazil ice is forming and conditions persist, or if photographs from the photo monitoring points are unavailable and condition persist, a crew is mobilized to site to perform assessments at established frazil ice monitoring sites.

The air temperature data from Pemberton Airport confirmed there was a single occurrence of six consecutive days of temperatures averaging <-5°C in February 2021. Concurrently, one occurrence of seven consecutive days of temperatures averaging <-5°C in February 2021 was observed at the Callaghan Valley Station.

Photographs of Boulder Creek and Upper Lillooet during the February 2021 event were provided by Innergex operations staff. Photographs were reviewed by an Ecofish QEP and it was determined that conditions did not warrant a site visit. The Boulder Creek facility shut down on February 11, 2021 therefore subsequent frazil ice assessments were not required in Year 3. The Upper Lillooet facility was shutdown on February 12, 2021 therefore subsequent frazil ice assessments were not required in Year 3.

2022 Monitoring Recommendations:

- Continue monitoring for frazil ice according to the OEMP.
- Recommendations for refinement of the protocol and thresholds will be provided once additional data are collected.

Fish Community

Adult Migration and Distribution

Adult fish distribution and migration during the spawning period within the diversion and downstream reaches of both the Upper Lillooet River and Boulder Creek, the tailrace of each facility, and a section on North Creek (a reference stream) were assessed through angling surveys in 2020. These surveys were conducted to determine if access to the two diversion reaches was impacted by water diversion. Adult Bull Trout were captured in the diversion and downstream reaches of Boulder Creek and the Upper Lillooet River. During Year 3, a total of six Bull Trout were captured during angling surveys in the Upper Lillooet River (five in the diversion reach and one in the tailrace), and a total of 38 Bull Trout were captured in Boulder Creek (17 in the diversion reach, 7 in the tailrace, and 14 in the downstream reach). At both HEFs, the absence of Bull Trout holding below the powerhouse, and detection of them in the diversion reach, suggests that movement into the diversion reach was not inhibited by operations in 2020. All assessed portions of the diversion reaches were also deemed to be accessible to fish, with no barriers to migration identified. Bull Trout were also captured in North Creek in Year 3.

Tributary bank walk spawner surveys were conducted in a reference tributary at km 29.2 of the Upper Lillooet River (29.2 km Tributary) and in Alena Creek. The peak numbers of spawning adult Bull Trout observed in 29.2 km Tributary were higher in 2020 (one) than in 2019 (zero) but were lower than 2018 (two) and in baseline surveys in 2011 (eight). The peak numbers of spawning adult Bull Trout observed in Alena Creek were lower in 2020 (zero) than in 2019 (one), 2018 (two), and baseline surveys in 2011 (nine). The reference stream data suggests that overall Bull Trout numbers may have been lower in 2020 than during baseline.

Water Quality

The objective of water quality monitoring is to identify biologically significant changes to specific water quality parameters stemming from Project development and operation using a BACI design.

Year 1 (2018) operational data collected at the Upper Lillooet River Hydroelectric Facility indicated that the parameters measured under operating conditions had very similar values compared to what was observed under baseline conditions. Parameter values were also within typical ranges for BC watercourses and within applicable BC WQG (MOE 2019) for the protection of aquatic life. No evidence of excessive gas entrainment during power generation through the Francis turbines was detected at the tailrace site during Year 1 (2018).

On-going monitoring of similar projects, which were reviewed by DFO (2016), suggest that biologically significant effects of Project operations on water quality are not likely to occur. In consideration of this, and the operational monitoring results for the Project, it was recommended that the water quality monitoring component be removed from the OEMP in Years 2, 3, 4, and 5.

Wildlife Species Monitoring

Harlequin Ducks

The objective of Harlequin Duck (*Histrionicus histrionicus*) response monitoring, which is a requirement of the Project's EAC (Condition #3 of the TOC), is to confirm that Harlequin Ducks continue to use the ULR HEF area post-construction. Spot checks were conducted in Year 3 with the use of zoomable surveillance cameras at the powerhouse and at the intake during the pre-incubation period ("pair" surveys; conducted on May 12, 18, and 26) and during the brood-rearing period ("brood" surveys conducted on August 5, 10, and 15).

No Harlequin Ducks were observed during spot checks in Year 3 (2020). The headpond had been drained during the spot check on May 26 (the headpond was drained between May 22 and July 20 due to a BC Hydro forced shutdown); however, it had not been drained earlier in May when Harlequin Ducks had also not been observed. Harlequin Ducks were also not incidentally observed in the Project area in 2020, although four unidentified ducks were observed in the headpond on April 20, 2020. The lack of detections of Harlequin Ducks during surveys in the last two monitoring years (2019 and 2020) may be related to the methods because surveillance cameras were used during those years rather than conducting surveys in person, as required by the protocols. Recommendations for Year 4 include: 1) continued annual monitoring for the next two years (with reporting in Year 5), in accordance with Project requirements; 2) conducting all spot checks in person, using binoculars or spotting scope, from specified vantage points as per the protocols, unless not possible for safety reasons; and 3) if possible, schedule operational maintenance of the headpond outside of the Harlequin Duck breeding period (May 1- August 1).

Species at Risk & Regional Concern

Wildlife species at risk and of regional concern are being monitored through the recording of incidental observations during the first five years of Project operations to contribute to the provincial database and to inform Project operations on situations that may require consideration of wildlife species likely to be present. Most wildlife species incidentally observed in 2020 have also been recorded in previous years; however, three species were detected that were not recorded during monitoring previously: Hoary Marmot (*Marmota caligata*); Fisher (*Pekania pennanti*), and Roosevelt Elk (*Cervus elaphus roosevelti*). Wolverines *(Gulo gulo luscus)* were not observed in 2020. Documenting incidental wildlife observations will continue in Years 4 and 5, as specified in the OEMP. To reduce the potential for human-wildlife conflict, it is recommended that Project personnel continue to record and share wildlife sightings with other Project personnel, especially of Grizzly Bear (*Ursus arctos*), Moose (*Alces americanus*), and Roosevelt Elk, and particularly along the Lillooet River Forest Service Roads (FSR).

Wildlife Habitat Monitoring

Habitat restoration monitoring for Harlequin Ducks and Peregrine Falcons (*Falco peregrinus*) was completed in Year 1.

Habitat Restoration - Amphibian Habitat

The objective of amphibian habitat restoration compliance monitoring is to confirm that key habitat restoration prescriptions were implemented post-construction for Coastal Tailed Frog (*Ascaphus truei*) terrestrial (riparian) and instream habitat. Compliance monitoring was completed at transmission line crossings and the penstock crossing in Year 1; however, geotextile had become exposed at the penstock crossing (ULL-ASTR04) within the riparian area and stream channel. Work was completed in the fall of 2019 to cover the exposed geotextile with additional rocky substrate, and a spot check was conducted in 2020. The spot check indicated that most of the geotextile that had been exposed in 2018 remained covered, but that a small portion (~ 0.8 m long) of geotextile had become exposed at the edge of river right, which was re-covered with cobble found on site. An additional spot check is recommended for Year 5, to be conducted in coordination with riparian revegetation monitoring, to determine whether the geotextile stays covered in the next two years.

Habitat Restoration - Mammal Habitat

The objective of mammal habitat compliance monitoring in 2020 was to confirm that habitat restoration measures prescribed to minimize sensory disturbance and visibility of the transmission line corridor from adjacent Project roads had been implemented for Grizzly Bear, Moose, and Mule Deer (*Odocoileus hemionus*) habitat. Year 3 monitoring involved confirming presence and adequacy (width and height) of vegetated screens between the transmission line RoW and active FSRs, where the transmission line RoW is within 10 m of an active FSR and passes through legislated protected habitat (Ungulate Winter Range (UWR) or Wildlife Habitat Area (WHA)) or high value Grizzly Bear habitat). Vegetated screens at 23 of 29 restoration monitoring sites had not attained the required height (5 m) or width (5 m) in Year 1, and reassessment in Year 3 was required. Other monitoring requirements (to confirm access roads in WHA 2-399 were deactivated, garbage and food waste were being disposed of properly, and plant composition requirements of vegetated screens were met) were completed in Year 1.

Results of mammal habitat restoration compliance monitoring for Grizzly Bear, Moose, and Mule Deer at restoration monitoring sites indicated that vegetated screens at 19 of the 23 restoration monitoring sites reassessed in Year 3 did not meet required dimensions. Growth of existing vegetation is expected to create an adequate screen over time at most of these sites, but at one site (ULH-MAMCM04B) planting is recommended in areas where growth is restricted by wood chips. It is also recommended that 18 sites where screens were inadequate in Year 3 are reassessed in Year 5 however; this recommendation will be reconsidered in Year 4 based on an upcoming assessment of site-specific transmission line safety constraints for vegetated screen height. It is recommended that monitoring is discontinued at one site where the screen did not meet the required dimensions as this site consists primarily of a scree slope where vegetation growth is naturally limited.

Mitigation Effectiveness – Mountain Goats

Mitigation effectiveness monitoring that evaluated measures developed to minimize avian mortality from transmission line collisions and to protect Mountain Goats (*Oreamnos americanus*) migrating along Truckwash Creek was completed in Year 1.

Mountain Goats at Boulder Creek HEF

The objectives of Mountain Goat effectiveness monitoring at the Boulder Creek HEF are to: 1) to evaluate the effectiveness of the gate in preventing public access to the intake during winter (November 1 to June 15); and 2) to evaluate predator presence and behavior within the Mountain Goat Ungulate Winter Range in the vicinity of the Boulder Creek HEF intake post-construction, which will be used to assess potential access-related increase in predation risk to Mountain Goats. These monitoring objectives were met in Year 3 of post-construction monitoring through remote infrared cameras placed along the access road and in the vicinity of the Boulder Creek HEF intake.

Access monitoring results indicated that the access road was inaccessible to the public by motorized vehicle when the gate was closed during the snow-free period. However, the gate becomes non-functional when buried by snow, and in Year 3, snowmobiles were documented accessing the intake area on February 29 by driving over the gate. Two public vehicles were also documented passing through the open gate during the snow-free period (May 15 and May 18, 2020). One of these passed through the gate because it was opened by Project personnel visiting the intake and the other passed through it after it had been vandalized (cut open).

Grey Wolf (*Canis lupus*), Grizzly Bear, and American Black Bear (*Ursus americanus*) were detected in the vicinity of the Boulder Creek HEF intake in Year 3. Grey Wolves, which are considered main predators of Mountain Goats were not detected during baseline and Year 1 monitoring but in Year 2 they were detected both on and off the access road during the winter period (November 1 to June 15), and in Year 3 they were detected off the road during the winter period (May 6) and on the road outside of the winter period (October 20); thus there is some indication that Grey Wolf use of the intake area has increased since Project construction. However, comparison of predator presence between pre - and post-construction periods is difficult due to typically low frequency of predator detections and because there may be some time required for predators to discover the road and adjust their habitat use. Cougars (*Puma concolor*) are another main predator of Mountain Goats, but they have been detected in the intake area only in Year 2 to date. Mountain Goats were not documented near the Boulder Creek HEF intake in Year 3 (2020).

We recommend that access and predator monitoring is continued for at least one additional year to determine if problems related to the gate and use of this area by snowmobiles continue and to evaluate if use of the intake area by main predators of Mountain Goats (especially Grey Wolf) has increased since Project construction. We also recommend that Project personnel are reminded to close the gate behind them even if only at the intake for a short period of time during the November 1 to June 15 winter period, that implementation of additional surveillance along the access road, as well as reporting of unauthorized road use, is considered, that signage to inform the public of the closure of the access road between November 1 and June 15 is improved by installing two large and highly visible signs (visible during both summer and winter), one at the base of the access road and one at the gate, and that gate modifications are considered to make the gate effective in preventing snowmobiles from driving up the access road to the intake when snow buries the current gate.

Vegetation Monitoring

The objectives of vegetation monitoring are to qualify and quantify the re-growth of vegetation in terrestrial areas disturbed through the construction of the Project, to mitigate short-term habitat loss, and to prevent the introduction of invasive species that may occur through site disturbance. Methods and results are presented in a separate report (Appendix B).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF MAPS

LIST OF APPENDICES

1. INTRODUCTION

Ecofish Research Ltd. (Ecofish) was retained by the Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership (collectively, the Partnerships) to conduct Year 3 of the operational environmental monitoring program (OEMP) for the Upper Lillooet Hydro Project (ULHP) (the Project). The Project is comprised of two run-of-river hydroelectric facilities (HEFs) located in the Upper Lillooet watershed, northwest of Pemberton, BC (Map 1). The largest of the two HEFs is located on the mainstem of the Upper Lillooet River (Watershed Code (WC): 119), and the smaller is located on Boulder Creek (WC: 119-848100). Infrastructure for each HEF includes a powerhouse and intake, and water is diverted, via penstock and/or tunnel, around approximately 3.8 km of the Upper Lillooet River, and around approximately 3.7 km of Boulder Creek, for the Upper Lillooet River HEF and the Boulder Creek HEF, respectively. Project infrastructure also includes a new 72 km long 230 kV transmission line that transports electricity produced by the Project to the point of interconnection, south of Pemberton, near Rutherford Creek (Map 1). A detailed effects assessment, addressing aquatic and terrestrial valued components, was completed for the HEFs and for the transmission line (Lewis *et al.* 2012, Leigh-Spencer *et al.* 2012, Hedberg and Associates 2011, Lacroix *et al.* 2011a, b, c, d, NHC 2011).

An operational environmental monitoring plan (OEMP) was developed for the Project by Ecofish Research Ltd. (Ecofish) to assess potential Project effects on the environment, fish communities, wildlife, and wildlife habitat present in the Project area (Harwood *et al.* 2017). The OEMP addresses the operational monitoring conditions identified during the environmental assessments (EAs) (Lewis *et al.* 2012, Leigh-Spencer *et al.* 2012, Hedberg and Associates 2011, Lacroix *et al.* 2011a, b, c, d, NHC 2011) and the conditions listed in Schedule B (Table of Conditions (TOC)) of the Project's Environmental Assessment Certificate (EAC) (E13-01; EAO 2013). The aquatic components of the OEMP are also based on the Fisheries and Oceans Canada (DFO) Long-term Aquatic Monitoring Protocols for New and Upgraded Hydroelectric Projects (Lewis *et al.* 2013a). Monitoring requirements address two types of effects: footprint and operational. Footprint effects are associated with Project structure and can be short or long-term, depending on the permanence of the infrastructure and associated disturbance, whereas aquatic operational effects result from changes to water flow for the purpose of project operation.

The OEMP prescribes three types of monitoring: compliance, effectiveness, and response. Compliance monitoring is conducted to ensure that conditions outlined in the EAC (EAO 2013), DFO Fisheries Act Authorization (09-HPAC-PA2-00303), and water licences are adhered to. Effectiveness monitoring is conducted to verify that mitigation and compensation measures implemented for a project are effective, and response monitoring is the long-term monitoring of environmental parameters to establish empirical links between project development and operation, and any effects on the environment. Compliance and effectiveness monitoring are conducted at specific locations based on the parameter being monitored. Response monitoring often requires data collection at multiple sites, with the locations dependent on the parameter(s) in question, so that

Project effects can be assessed through a comparative study design. Effectiveness and response monitoring can lead to, and facilitate, the adaptive management of impacts.

This report presents results from Year 3 (2020) of operational monitoring in accordance with requirements of the OEMP (Harwood *et al.* 2017). Aquatic and terrestrial monitoring parameters and components, which are summarized in Table 1 and Table 2 respectively, each have specific requirements, including frequency, duration, and reporting.

Aquatic monitoring requirements follow recommendations from Hatfield *et al.* (2007) and Lewis *et al.* (2013a) (with a few exceptions noted in Harwood *et al.* (2017)). Aquatic monitoring parameters include primary parameters (instream flow, mitigation and compensation, aquatic and riparian habitat, water temperature and icing (i.e., frazil ice), stream channel morphology, and fish abundance and behaviour (i.e., fish community)) and secondary parameters (water quality and species at risk and of concern) (Table 1). A number of aquatic monitoring components are only conducted once and have now been completed (see Year 1 report). These include footprint impact verification and water quality monitoring. As such, Year 3 monitoring results presented in this report consist of study components related to riparian vegetation, water temperature/icing, and fish community. The monitoring program for the Project's fish habitat compensation project, Alena Creek, is presented in Appendix A as a standalone report. Stage and discharge monitoring for instream flow release (IFR) and ramping compliance are monitored in real time year-round and are presented in annual compliance reports submitted separately for the life of the Project.

Terrestrial monitoring parameters included in the OEMP are wildlife species, wildlife habitat, and vegetation (Table 2). Results of monitoring components scheduled for Year 3 and reported on here include response monitoring for Harlequin Ducks (*Histrionicus histrionicus*) and for species at risk and of regional concern, and effectiveness monitoring related to the Boulder Creek HEF intake area (public access and predator monitoring). Habitat restoration monitoring for mammals was completed in Year 1 and additional monitoring was recommended in Year 3 to confirm that vegetated screens had attained their required size. Habitat restoration monitoring was also been completed for Coastal Tailed Frogs (*Ascaphus truei*) in Year 1 and a spot check was recommended in Year 3 to confirm that all restoration prescriptions were implemented at the penstock crossing of the Upper Lillooet River HEF. All other monitoring components that were scheduled to occur only in Year 1 (Table 2) have been completed, including avian habitat restoration monitoring and avian collisions and Truckwash Creek portal design mitigation effectiveness monitoring. As discussed in the Year 1 report, vegetation monitoring was recommended to occur in Year 3 (and not in Year 2 as stated in Table 2), with the exception of a survival survey, which was conducted recommended for Year 2. The Year 3 survey was completed by Hedberg and Associates Consulting Ltd. (Johnston 2020) and is presented in Appendix B.

Project Overview

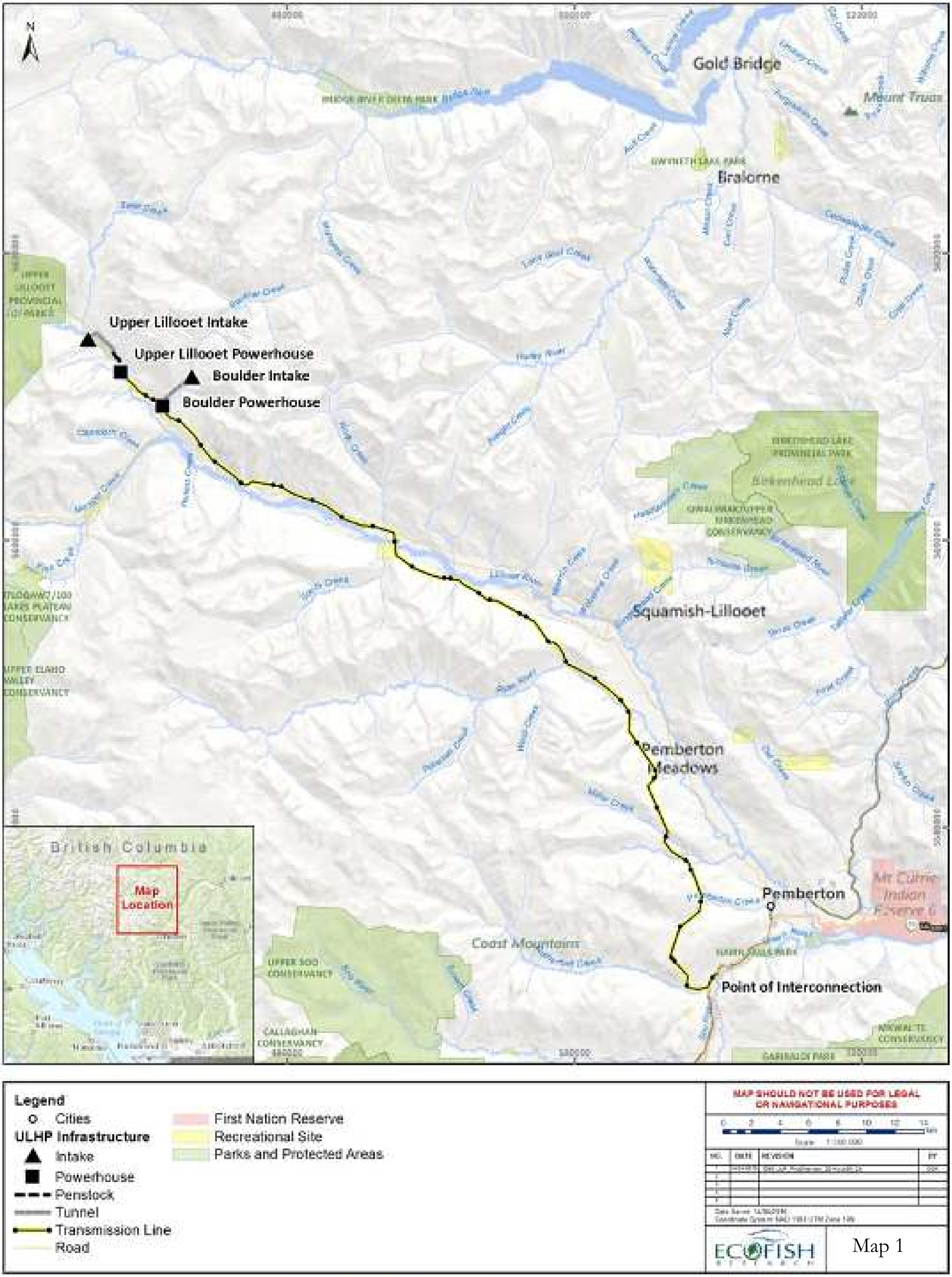


Table 1. Summary of aquatic monitoring parameters and components specified in the updated OEMP (Harwood *et al.* 2017).

Parameter	Project Component	Monitoring Type	Facility	Monitoring Requirements		
				Frequency	Duration[1]	Reporting[2]
Primary						
Instream flow	Flow magnitude and timing	Compliance	ULL, BDR	Continuous	Life of project	Annually
	Ramping rates	Compliance	ULL, BDR	Once[3]	Project commissioning	Once
		Compliance	ULL, BDR	Continuous	Life of project	Annually
Mitigation and compensation measures	Compensation projects	Compliance	ULL	Once	Immediately post-construction	Once
		Effectiveness	ULL	Annually	Years 1 to 5	Annually
Aquatic and riparian habitat	Footprint impact verification	Compliance	ULL, BDR	Once	Immediately post-construction	Once
	Revegetation assessment	Effectiveness	ULL, BDR	Annually	Years 1, 3 and 5	Annually
Water temperature and icing	Overall project	Response	ULL, BDR	Continuous	Life of project	Annually
Stream morphology	Overall project	Response	ULL, BDR	Once	Year 5, or after 1 in 10 year event	Once
Fish abundance and behaviour	Compensation projects	Effectiveness	ULL	Annually	Years 1 to 5	Annually
	Resident fish density (EF)	Response	ULL	Annually	Years 1 to 5	Annually
	Resident fish density (SN)		BDR	Annually	Years 1 to 5	Annually
	Migration and spawning (BT)	Response	ULL, BDR	Annually	Years 1 to 5	Annually
	Migration and spawning (CT)		ULL	Annually	Year 1	Annually
Secondary						
Water quality	Overall project	Response	ULL, BDR	Quarterly	Year 1	Annually
Species at risk or of concern[4]	BT and CT	Response	ULL, BDR	Annually	Years 1 to 5	Annually

ULL = Upper Lillooet River, BDR = Boulder Creek; EF = electrofishing, SN = snorkeling; BT = Bull Trout, CT = Cutthroat Trout.

1: Monitoring may be extended past the prerequisite minimum of five years following review of the results from the five year operational monitoring period.

2: Non-compliance must be reported on an accelerated schedule and measures taken to ameliorate risk. Non-compliance reports due shortly after event.

3: Ramping rate tests need only be conducted once if fry are present.

4: Bull Trout and Cutthroat Trout are both blue listed in BC (special concern) and will be monitored as part of regular fish response monitoring.

Table 2. Summary of terrestrial monitoring parameters and components specified in the updated OEMP (Harwood *et al.* 2017). Note that vegetation monitoring is not addressed in this report but is reported on separately.

Monitoring Parameters	Component	Sub-component	Monitoring Type	Facility	Monitoring Requirements		
					Frequency[1]	Duration	Reporting
Wildlife Species	Harlequin Ducks	-	Response	ULL	Multiple	Years 1, 3 and 5	Years 1, 3 and 5[2]
	Species at Risk & Regional Concern	-	Response	ULL	Continuous	Years 1 to 5	Annually[3]
Wildlife Habitat	Habitat Restoration	Coastal Tailed Frog Habitat	Compliance	ULL	Once[4]	Immediately post-construction	Once
		Harlequin Duck Habitat	Compliance	ULL	Once[4]	Immediately post-construction	Once
		Peregrine Falcon Habitat	Compliance	ULL	Once[4]	Immediately post-construction	Once
		Grizzly Bear	Compliance	ALL	Once[4]	Immediately post-construction	Once
		Moose & Mule Deer Habitat	Compliance	ULL	Once[4]	Immediately post-construction	Once
		Mountain Goat Habitat	Compliance	ULL, BDR	Once[4]	Immediately post-construction	Once
	Mitigation Effectiveness	Avian Collisions	Effectiveness	ULL	Bi-annually	Year 1[4]	Annually
		Truckwash Creek Portal Design for Mountain Goats	Effectiveness	ULL	Multiple	Year 1[4]	Annually
		Boulder Creek HEF Gate Winter Access Monitoring	Effectiveness	BDR	Multiple	Years 1 to 3[4]	Annually
		Boulder Creek Predator Presence & Behaviour Monitoring	Effectiveness	BDR	Multiple	Years 1 to 3[4]	Annually
Vegetation	Vegetation Restoration		Compliance/ Effectiveness	All	Annually	Years 1 to 5	Annually
	Invasive Plants		Compliance/ Effectiveness	All	Annually	Years 1 to 5	Annually

ULL = Upper Lillooet River, BDR = Boulder Creek

[1] Monitoring data collection may occur only once, annually, bi-annually, or on multiple occasions within a year.

[2] Data will compiled annually and results will be analyzed in years 1, 3, and 5.

[3] Reporting requirements consist of compilation of data and presentation in an appendix according to provincial format.

[4] Monitoring may be extended if required.

2. OBJECTIVES AND BACKGROUND

2.1. Instream Flow Monitoring

To measure compliance with the instream flow requirement (IFR) set out in the DFO *Fisheries Act* Authorization and conditional water license, accurate, real-time, instantaneous flow data are being collected throughout the life of the Project. Ramping rate compliance reporting is also required for the life of the Project. The IFR and ramping compliance reporting for Year 3 will be completed separately by ULHP.

2.2. Mitigation and Compensation Measures

Habitat compensation for the Project was completed on Alena Creek. Monitoring results are included in Appendix A.

2.3. Aquatic and Riparian Habitat

2.3.1. Riparian Revegetation Assessment

The objective of the riparian revegetation effectiveness monitoring component of the OEMP (Harwood *et al.* 2017) is to evaluate the early successional growth and survival of natural and planted vegetation within riparian areas disturbed by Project construction to ensure compliance criteria are met. During permitting, the Project committed to restoration of riparian areas that had been temporarily impacted during Project construction in accordance with the DFO and MELP (1998) riparian areas and revegetation protocols and site restoration protocols outlined in Standards and Best Practices for Instream Works (MWLAP 2004). Following the completion of the Project, the construction contractor (CRT-ebc 2016) was required to revegetate disturbed areas, and a detailed site-specific reclamation and revegetation plan was developed (McKeachie 2016) that was consistent with requirements in the Project Construction Environmental Management Plan (CEMP; Innergex 2013). In combination with amphibian habitat restoration monitoring (Section 2.9.1), riparian revegetation monitoring also contributes to the assessment of disturbed riparian areas along Coastal Tailed Frog streams.

Site reclamation and revegetation was completed following Project construction. Riparian site reclamation (i.e., replacement of stockpiled topsoil and coarse wood) and revegetation began in the fall of 2014 and was completed by the spring of 2017 (Woodruff *et al* 2017). Riparian reclamation and revegetation efforts included, but were not limited to, preparing the substrate, adding topsoil, distributing coarse woody debris, and planting vegetation to density, species composition, spacing, and distribution specifications (McKeachie *et al.* 2016). Dave Polster, native plant community reclamation expert, provided additional direction on the application of local alder seed on the steep slopes above the portal and laydown area of the ULR HEF intake sites (CRT-ebc 2016). The Independent Environmental Monitor (IEM) confirmed that reclamation works were complete for the Project (Hicks 2017). In addition, Hedberg and Associates Consulting Ltd. confirmed that revegetation was completed at the Boulder Creek Hydroelectric Facility (HEF) powerhouse and the

Upper Lillooet River (ULR) HEF intake, penstock (including at two Coastal Tailed Frog streams), downstream portal, and powerhouse (Barker and Staven 2017).

Successful riparian revegetation was evaluated during effectiveness monitoring in accordance with DFO and MELP (1998) revegetation guidelines. Operational monitoring of revegetation was recommended for years 1, 3, and 5 of operations (Table 1, Harwood *et al.* 2017). This monitoring schedule differs from that proposed in the DFO long-term monitoring protocols (years 1 through 5) because results from similar projects suggest that annual monitoring is not required. However, if concerns are identified, additional monitoring and/or management actions may be required (Harwood *et al.* 2017). This report presents riparian revegetation monitoring results from Year 3.

2.4. Water Temperature and Air Temperature

Water extraction has the potential to increase water temperature in the summer and decrease water temperature in the winter (Meier *et al.* 2003). Fish may be vulnerable to both small increases and decreases in water temperature, with tolerance levels varying between species and life-history stages. Water temperature and frazil ice (Section 2.4.1) will be monitored continuously in the Upper Lillooet River and Boulder Creek for the life of the project, as per the EAC (EAO 2013). The objective of monitoring water temperature is to identify any biologically significant differences (as defined in Harwood *et al.* 2017) between baseline and operational temperature regimes in the streams. To achieve this, water temperature will be monitored continuously for the first five years of operation and compared to the baseline data using a Before-After-Control-Impact (BACI) design.

It was identified that there was a risk that the Upper Lillooet River upstream control water temperature loggers (ULL-USWQ02) could not be reliably accessed for data retrieval and maintenance, therefore in November 2018 an additional upstream control site (ULL-USWQ03) was established to replace the original site (Map 2).

It was also identified that the baseline water temperature regime at the upstream site in Boulder Creek (BDR-USWQ) was influenced by groundwater from late fall to early spring, therefore a new upstream location was established in October 2019 for operational sampling in Boulder Creek (BDR-USWQ2) (Map 3). In addition, a site was established in North Creek (NTH-USWQ1) for the purpose of replacing baseline data compromised by groundwater inflow during the late fall to early spring period, following at least one year of concurrent water temperature monitoring.

Commencing in Year 1 of operations (March 2018 at most sites), water temperature was monitored at five sites for each Project: two upstream sites, one site in the lower diversion, one site in the tailrace, and a downstream site (Map 2, Map 3).

This Year 3 (2020) annual monitoring data report provides a summary of baseline (2008-2013) and operational (March 2018 - October 2020) water and air temperature monitoring results for the Upper Lillooet River and Boulder Creek HEFs. This report is intended to be primarily a data summary report. Any changes in water temperature related to the operation of each Projects will be evaluated with a BACI analysis following five years of operational water temperature data collection.

2.4.1. Frazil Ice

The objective of monitoring frazil ice is to mitigate potential adverse effects of frazil ice build-up on the availability of overwintering habitat for fish during Project operation. The formation of frazil ice is largely dictated by localized climatic factors, such as air temperature, humidity, and wind speed, as well as instream characteristics, such as water temperature, flow rates, and channel morphology. Generally, frazil ice forms when flowing water is super-cooled to less than 0.08°C by very cold air temperatures (Calkins 1993). For this reason, data from Environment Canada meteorological stations in the vicinity of the Project area (Pemberton Airport and Callaghan Valley) are being monitored for conditions that may result in ice formation. When the climate and weather conditions indicate that there is potential for frazil or anchor ice formation, a protocol is initiated that, depending on local air temperatures, the status of Project operations, and visible evidence of ice formation within the HEF diversion reaches, may result in a field survey to evaluate the extent of frazil ice formation and to determine the appropriate response. As stated in the OEMP, HEF shutdowns will be recommended if visual site assessments indicate that frazil ice displaces ≥50% of the fish holding habitat within the hydraulic units (monitoring sites) surveyed, otherwise HEF shutdowns will not be recommended but monitoring of air temperatures and monitoring sites will continue until the risk of frazil ice abates.

2.5. Stream Channel Morphology

Operational monitoring of stream morphology will be conducted 5 years after facility commissioning as outlined in the OEMP (Harwood *et al.* 2017).

2.6. Fish Community

The construction and operation of a run-of-river hydroelectric facility has the potential to affect the health of the fish community directly or indirectly. The objective of the fish community monitoring program is to assess fish community response during operations and identify any changes in abundance, density, condition, distribution, or timing of migration relative to baseline. As per the OEMP, the focal species of fish community monitoring are Cutthroat Trout (*Oncorhynchus clarkii*) and Bull Trout (*Salvelinus confluentus*) within the Upper Lillooet River, and Bull Trout within Boulder Creek. The monitoring program assesses potential Project effects on fish communities in response to Project operations using a BACI study design. Fish community monitoring, as outlined in the OEMP, includes sub-components of juvenile density and biomass, adult migration and distribution, and entrainment at the Upper Lillooet River HEF intake (Harwood *et al.* 2017). Juvenile fish density and biomass (sampling for which also informs monitoring of entrainment in the Upper Lillooet HEF intake) was not monitored in Year 3 due to site safety concerns, and the OEMP is currently undergoing revision to address these concerns and determine an alternate sampling design for this component. Thus, monitoring in Year 3 was focused on the single “adult migration and distribution” fish community monitoring sub-component. This monitoring sub-component specifically targets Bull Trout and fieldwork was therefore done during the Bull Trout spawning window; however, any captured Cutthroat Trout were also processed. The objective of this sub-component is to ensure that IFR flows, along with local inflows and spill events, are adequate to allow the upstream spawning migration of Bull Trout into the Project streams.

Methods used for fish community monitoring should be appropriate for the system and fish species and/or life-stage of interest (Lewis *et al.* 2013). Accordingly, angling and bank walk surveys were used for monitoring adult migration and distribution. Angling surveys were conducted at established monitoring sites (shown in Map 5) in high-grade Bull Trout habitat, that had been identified by experienced fisheries technicians. Bank walk surveys were conducted from the confluence with the Upper Lillooet River upstream to the same end point on each survey.

The design of this monitoring component is described in detail in the OEMP (Harwood *et al.* 2017). For the adult migration and distribution component, monitoring was conducted in the diversion and downstream reaches of both the Upper Lillooet River and Boulder Creek (impact reaches) as well as in three reference streams (tributary at river km 29.2 of the Upper Lillooet River, Alena Creek, and North Creek). Alena Creek is also the location of the fish habitat compensation for the Project.

2.7. Water Quality

The objective of water quality monitoring is to identify biologically significant changes to specific water quality parameters stemming from Project development and operation using a BACI design.

Year 1 (2018) operational data collected at the Upper Lillooet River Hydroelectric Facility indicate that the parameters measured under operating conditions have very similar values compared to what was observed under baseline conditions. Parameter values are also within typical ranges for BC watercourses and within applicable BC WQG for the protection of aquatic life. No evidence of excessive gas entrainment during power generation through the Francis turbines was detected at the tailrace site.

On-going monitoring of similar projects, which were reviewed by DFO (2016), suggest that biologically significant effects of Project operations on water quality are not likely to occur. In consideration of this and the operational monitoring results for the Project, Regehr (2019) recommended that that the water quality monitoring component be removed from the OEMP in Years 2, 3, 4, and 5.

Alkalinity will continue to be monitored once per year in conjunction with fish sampling for use in calculations of stream productivity (Harwood *et al.* 2017).

2.8. Wildlife Species Monitoring

Project footprint and operational effects are being evaluated for select wildlife species through response monitoring with the objective of evaluating potential operational effects and providing an opportunity to adaptively manage any such identified effects. Response monitoring is prescribed in the OEMP for Harlequin Ducks (*Histrionicus histrionicus*) and for species at risk and of regional concern. Response monitoring was also originally prescribed for Coastal Tailed Frogs (*Ascaphus truei*); however, due to impacts of the Boulder Creek wildfire in 2015, compliance monitoring of stream restoration was instead prescribed (Harwood *et al.* 2017) which was completed in Year 1 with one exception described in Section 2.9.1 (Regehr *et al.* 2019). Monitoring of Grizzly Bears (*Ursus arctos*) is being conducted at a regional scale through financial support for the regional provincial population trend monitoring and collaboration on access management (see Harwood *et al.* 2017) and is therefore not a component of the OEMP. Response monitoring for Harlequin Ducks and species at risk and of regional concern was conducted in Year 3 and will continue for the next two years (Table 2).

2.8.1. Harlequin Ducks

Annual monitoring continues for Harlequin Ducks (*Histrionicus histrionicus*) at the Upper Lillooet River HEF (intake and powerhouse), with detailed reporting presented in Years 1, 3, and 5, and brief reporting, consisting of a summary table of results, presented in Years 2 and 4.

2.8.2. Species at Risk & Regional Concern

Monitoring of species at risk and of regional concern (as identified within the Sea to Sky Land and Resource Management Plan (MAL 2008)) has two main objectives. First, data on the presence and distribution of wildlife species at risk and of regional concern will be used to determine occupancy and locations of occurrences relative to Project infrastructure; this will allow identification of occurrences that may be affected by Project operations and will inform Project operations on situations that may require consideration (e.g., modification of timing of activities). Second, collection and submission of these data to the province will contribute to the provincial database.

2.9. Wildlife Habitat Monitoring

Monitoring for several wildlife habitat sub-components was completed in previous years. Avian habitat restoration prescribed for Harlequin Ducks and Peregrine Falcons (*Falco peregrinus*) were completed in Year 1 (Regehr *et al.* 2019; Table 2). Similarly, mitigation effectiveness monitoring that evaluated measures developed to minimize avian mortality from transmission line collisions and to protect Mountain Goats (*Oreamnos americanus*) migrating along Truckwash Creek from sensory disturbance and movement disruption related to the ULR HEF was completed in Year 1 (Regehr *et al.* 2019; Table 2). Two wildlife cameras (ULL-CAM02 and ULL-CAM15) were left in place along the Truckwash Creek migration corridor and observations of species at risk and regional concern from these cameras are included as incidental observations.

2.9.1. Habitat Restoration – Amphibian Habitat

The objective of amphibian habitat restoration compliance monitoring is to confirm that key habitat restoration prescriptions were implemented post-construction for Coastal Tailed Frog terrestrial (riparian) and instream habitat. Habitat restoration measures were prescribed for riparian Coastal Tailed Frog habitat where the transmission line crosses over suitable Coastal Tailed Frog streams, and for both riparian and instream habitat where the Upper Lillooet River HEF penstock crosses a tributary occupied by Coastal Tailed Frogs (ULL-ASTR04). Compliance monitoring was completed at transmission line crossings in Year 1 and no further monitoring is required. However, geotextile had become exposed at ULL-ASTR04 within the riparian area and stream channel (Regehr *et al.* 2019).

Following recommendations made in Year 1, work was completed in the fall of 2019 at ULL-ASTR04 to cover exposed geotextile with additional rocky substrate. Also, as per recommendation in Year 1, a spot check of instream Coastal Tailed Frog habitat at the penstock crossing (ULL-ASTR04) was conducted in coordination with riparian revegetation monitoring in Year 3 (2020) to evaluate whether the geotextile was covered.

2.9.2. Habitat Restoration – Mammal Habitat

Mammal habitat restoration measures were prescribed for Grizzly Bear, Moose (*Alces americanus*), and Mule Deer (*Odocoileus hemionus*) owing to potential effects to habitat of these species during Project construction and to the potential for sensory disturbance that may result when vegetation is cleared and/or access is increased. The objective of mammal habitat compliance monitoring was therefore to confirm that habitat restoration measures had been implemented. For all three species, this involved:1) confirming that vegetated screens had been maintained or restored between the transmission line RoW and active Forest Service Roads (FSR), where the transmission line RoW is within 10 m of an active FSR and the transmission line RoW passes through legislated protected habitat (Ungulate Winter Range (UWR) or Wildlife Habitat Area (WHA)) or high value Grizzly Bear habitat; and 2) that the composition of planted stems met species-specific requirements, as required by conditions of the Project's EAC and GWM exemptions (Table 3). In total, 29 restoration monitoring sites were identified in Year 1 where vegetated screen assessment was conducted. For Grizzly Bears, compliance monitoring was also required to confirm deactivation of access tracks/roads within WHA 2-399 and adherence to food attractant management requirements (outlined in the Human-Bear Conflict Management Plan (Regehr *et al.* 2014) as required by Condition #12 of the TOC).

As stated in Year 1 (Regehr *et al.* 2019) or Year 2 (Harwood *et al.* 2021) reports, access roads in WHA 2-399 were confirmed to have been deactivated, garbage and food waste were being disposed of properly, and greater than 50% planted vegetation composed of native fruit bearing shrubs was confirmed (requirements for Grizzly Bear). Further, revegetation requirements for planted vegetation for Moose and Mule Deer were adequately addressed in Year 1. Thus, these monitoring components were considered complete. However, Year 1 monitoring (Regehr *et al.* 2019) indicated that many vegetated screens had not attained the required height (5 m), and some had also not attained the required width (5 m). Thus, reassessment in Year 3 was required for 23 of the 29 sites to evaluate if the vegetated screens meet the requirements specified in the OEMP.

Table 3. Compliance monitoring required for mammal species (from Harwood *et al.* 2017) (see text for items previously confirmed complete).

Species	Project Component	Facility	Location	Prescription
Grizzly Bear	Upper Lillooet River HEF	Transmission Line	WHA 2-399	• A vegetated screen is maintained or is regrowing between the transmission line RoW and WHA 2-399, following construction and vegetation maintenance.[1] • At least 50% of the planted stems within the revegetated portion of the Grizzly Bear WHA 2-399 are native fruit bearing shrubs.[4] • Temporary roads or access tracks are deactivated and non-drivable with an ATV.[4]
			South Lillooet River FSR	• A vegetated screen (5 m high and wide) is maintained or is regrowing between the transmission line RoW and the Lillooet South FSR where feasible.[2,3]
			All	• A vegetated screen (5 m high and wide) is maintained or is regrowing between field verified suitable foraging habitat (Class 1 and Class 2) and roads or transmission line RoWs, and additional clearings, wherever feasible, following construction and vegetation maintenance.[2,3]
	All	All	All	• Food waste is being disposed of in animal proof containers.
Moose	Upper Lillooet River HEF	Transmission Line	All	• Vegetated screens (5 m high) are permitted to grow where the transmission line RoW is within 10 m of active FSRs or permanent Project access roads, within the Moose ungulate winter range (UWR), where feasible.[2,3] • At least 50% of the planted stems within the revegetated portion of the Moose UWR, away from road verges, are preferred Moose forage species (Appendix A).[5]
Mule Deer	Upper Lillooet River HEF	Transmission Line	All	• Vegetated screens (5 m high and wide) are maintained or are regrowing where the transmission line RoW is within 10 m of active FSRs or permanent Project access roads, within the Deer UWR, where feasible.[2,3,5] • Revegetated portion of the Deer UWR were planted with native species.[5]

[1] Condition 12 of the Project's EA Certificate (EAO 2013) and condition of the GWM Exemption 39585-20 WHA (Berardunicci 2013b).

[2] WorkSafeBC safety constraints may prevent such a high screens as the transmission line is designed to meet the CSA Standards.

[3] Note that locations where maintaining a vegetated screen was not feasible must be documented and presented to EAO during the construction phase, as stated within Condition 12 of the Project's EA Certificate (EAO 2013).

[4] Condition of the GWM Exemption 39585-20 WHA (Berardunicci 2013b).

[5] Condition of the GWM Exemption 78700-35/06 UWR (Berardunicci 2013b).

2.9.3. Mitigation Effectiveness - Mountain Goats at Boulder Creek

Mitigation effectiveness monitoring is being conducted during at least the first three years of operations to evaluate protection of Mountain Goats within UWR u-2-002 UL12 in the lower Boulder Creek watershed from potential effects related to increased access by humans and predators (Table 2). The intake and ancillary components for the Boulder Creek HEF were placed within a Mountain Goat winter range (UWR u-2-002 UL 12) (Map 2). Thus, upgrades to a pre-existing road and construction of a new segment of road required for the intake presented potential risks to Mountain Goats through increased access into the winter range by people and Mountain Goat predators. The Project's TOC (Condition #15) and conditions of the GWM Exemption that was issued to allow construction and operation of the Boulder Creek HEF within the winter range (Berardinucci 2013a, Barrett 2015, Blackburn 2016) therefore required that a gate must be installed and kept closed to prevent motorized public access during winter and spring (November 1 to June 15; Barrett 2015) and that it must be effective in preventing such access. The GWM Exemption also required that the presence and behaviour of predators, which may have changed due to new access into the winter range, must be monitored to allow assessment of associated risk to Mountain Goats.

Given the requirements of the EAC and GWM Exemption, there are two objectives of Mountain Goat effectiveness monitoring at the Boulder Creek HEF: 1) to evaluate the effectiveness of the gate in preventing public access during winter; and 2) to evaluate predator presence and behavior within the UWR post-construction which will be used to assess potential access-related increase in risk to Mountain Goats. Year 1 monitoring results indicated that the access road beyond the gate was accessible by one member of the public on ATV on one occasion during the snow-free period when the gate was required to be closed and, in accordance with recommendations made in Year 1, a lock block was placed on the upslope side of the gate in 2019 to prevent potential motorized access around the gate. Also, in accordance with recommendations made in Year 1, an internal electronic reminder was set up to ensure the gate would be closed on November 1 (Katamay-Smith 2020, pers. comm.) and signage was posted at the base of the access road to inform the public of the road closure from November 1 to June 15. It was also noted in Year 1 that the gate becomes non-functional due to burial from snow and therefore will not impede snowmobile access the access road; however, monitoring in both Year 1 and Year 2 did not document members of the public crossing over the gate when the gate was buried in snow.

Monitoring from Year 1 did not identify differences in predator use or activity between pre- and post-construction; however, monitoring in Year 2 documented Grey Wolves (*Canis lupus*) and Cougars (*Puma concolor*) in the vicinity of the Boulder Creek HEF intake, both on and off the access road. These species, which are considered main predators of Mountain Goats (Shackleton 1999), had not been detected in the vicinity of the intake during baseline or Year 1 monitoring. Three years of Mountain Goat effectiveness monitoring at the Boulder Creek HEF have now been completed and the need for additional monitoring is evaluated by a QP herein, as per requirements of the OEMP (Harwood *et al.* 2017; Table 2).

2.10. Vegetation Monitoring

The objectives of vegetation monitoring are to qualify and quantify the re-growth of vegetation in terrestrial areas disturbed through the construction of the Project, to mitigate short-term habitat loss, and to prevent the introduction of invasive species that may occur through site disturbance. Methods and results are presented in a separate report (Appendix B).

3. METHODS

3.1. Aquatic and Riparian Habitat

3.1.1. Riparian Revegetation Assessment

Riparian revegetation effectiveness monitoring is designed to allow tracking of revegetation progress and thereby to confirm that a diversity of well-established native tree and shrub species with low observed mortality rate is achieved. The monitoring design has three main elements (Harwood *et al.* 2017):

1) Use of permanent revegetation monitoring plots to estimate density, species composition, and survival of woody vegetation;
2) Use of quadrats to estimate percent vegetation cover; and
3) Use of photopoint monitoring to provide a visual, qualitative evaluation of revegetation success.

Twelve permanent revegetation monitoring plots (also referred to as "plots") were established in 2018 (Year 1) within revegetated riparian areas associated with Project infrastructure and ancillary components as a means of tracking revegetation progress. Eleven of these plots were placed in association with ULR HEF infrastructure: three at the intake, six along the penstock, and two near the powerhouse. Two of the ULR HEF penstock plots (ULL-PRM08 and ULL-PRM09) were placed adjacent to a Coastal Tailed Frog stream (Map 6) to contribute to the assessment of disturbed riparian areas along ULL-ASTR04 that was completed in Year 1 (Section 2.9.1). One plot was placed near the Boulder Creek HEF powerhouse (Table 4, Map 6).

Plot locations were selected to be representative of the site conditions (e.g., soil, slope, moisture) present in the revegetated areas they represented. Their locations were also selected to be at, or near, vantage points with views of the revegetated areas, which was needed for effective photographic monitoring. Plot locations selected in Year 1 of the monitoring program were used for Year 3 monitoring and will be used for Year 5 monitoring. Revegetation monitoring in Year 3 was conducted on September 1 and 2, 2020.

Each of the three main monitoring elements is described in the sections below.

Table 4. Locations of permanent riparian revegetation monitoring plots surveyed on September 1 and 2, 2020.

Location	Permanent Monitoring Plot	UTM Coordinates Zone	Easting	Northing	Description
Boulder Creek HEF Powerhouse	BDR-PRM01	10U	471338	5609325	River right of the Boulder powerhouse tailrace. Representative of the revegetation on the slope below the road adjacent to Boulder Creek.
Upper Lillooet River HEF Intake	ULL-PRM01	10U	466045	5614094	River right of Upper Lillooet River and upstream of the intake. Site provides a view of naturally revegetating slope.
	ULL-PRM02	10U	466236	5614031	River right of Upper Lillooet River and downstream of the intake. Site provides view of naturally revegetating slope. Slope is rough and loose.
	ULL-PRM03	10U	466112	5614110	River left of Upper Lillooet River and upstream of the intake. Site provides view for monitoring the revegetation on the slope below the road and above the intake.
Upper Lillooet River HEF Penstock	ULL-PRM04	10U	467946	5612993	River right of Truckwash Creek.
	ULL-PRM05	10U	468001	5612957	River left of Truckwash Creek.
	ULL-PRM06	10U	468188	5612695	River right of a tributary to the Lillooet River and upslope of the road.
	ULL-PRM07	10U	468215	5612654	River left of a tributary to the Lillooet River and downslope of the road.
	ULL-PRM08	10U	468392	5612384	River right of ULL-ASTR04, representative of the revegetated upper bench.
	ULL-PRM09	10U	468398	5612361	River left of ULL-ASTR04.
Upper Lillooet River HEF Powerhouse	ULL-PRM10	10U	468428	5611630	River left of the Upper Lillooet River HEF tailrace. Representative of the revegetated slope above the tailrace.
	ULL-PRM11	10U	468407	5611689	River right of the Upper Lillooet River HEF tailrace, representative of the revegetated slope above the tailrace.

3.1.1.1. Density, Species Composition, and Survival of Woody Vegetation

Woody vegetation is the primary focus of riparian revegetation monitoring due to its long-term contribution to the maintenance and enhancement of riparian habitat and function. Plots were established to measure the density and survival of perennial woody vegetation. The fixed-area circular plots were 50 m^2 in size, in accordance with the BC Silviculture Stocking Survey Procedures (MFLNRO 2015) and vegetation tally procedures employed by the Stand Development Monitoring Protocol (MFLNRO 2014).

Revegetation performance was evaluated in permanent revegetation monitoring plots through comparison with the DFO and MELP (1998) riparian revegetation guideline target stem density values. Effective revegetation is evaluated based on 80% survival of initial plant stock with a maximum target spacing of 2.0 m (or less, if appropriate, considering the size of mature stock). However, no distinction was made between vegetation that had been planted and that which had regenerated naturally because the objective of the monitoring was to evaluate successful revegetation by any means, and therefore survival could not be estimated. Instead, the proportion of dead stems to living stems (considering both planted and naturally regenerating stems) was used to provide general information on survival and possible trends in revegetation, in conjunction with other measures such as density.

Spacing and target densities were calculated with the following formula: spacing (m) =√(11,547/# stems per hectare) (Forest Renewal BC 2001). Thus, the target density, based on single-stemmed plants planted 2.0 m apart, is 2,887 stems per hectare (stems/ha). To meet the target of 80% survival, spacing must average 2.2 m and vegetation must have a density of 2,309 stems/ha. This density was considered when setting the average target densities of 1,200 tree stems/ha and 2,000 shrub stems/ha by the end of the monitoring period (Harwood *et al.* 2017). To evaluate whether this target has been achieved across all revegetation areas, 90% confidence limits calculated from a two-tailed t-distribution were generated to reflect sample size and among-plot variability.

Within each of the twelve permanent revegetation monitoring plots (Table 4, Map 6), the number of stems of all native perennial woody plants (which includes trees and shrubs, and excludes forbs, grasses, and mosses) were counted and health and mortality checks were conducted. Stems were defined as those stems of a plant that are distinctly individual at ground level. Tree or shrub seedlings that had secondary leaves that were at least the size of a quarter were large enough to be considered established and were counted, and stems were counted regardless of plant height, spacing, or species. Stems showing signs of abiotic stress, insect damage, fungal blights or other afflictions were all counted as living, although incidences of the disease and the host plant species were noted. As invasive plant species can impede the establishment of native woody vegetation, invasive plant species were recorded and hand-pulled, if feasible, when encountered.

3.1.1.2. Percent Vegetation Cover

Grasses and herbs, in addition to woody species, provide sediment and erosion interception and ground stabilization early in the revegetation process. Quadrats were used to estimate the percent cover of low-lying vegetation within the revegetation areas represented by the permanent monitoring plots. Percent cover of vegetation was estimated within a 0.25 m^2 quadrat divided into 25 - 10 x 10 cm squares. Quadrats were placed on the ground and the 25 squares were used to guide vegetation cover estimates. For example, if 20 squares were filled with vegetation, the total estimated percent cover of the quadrat would be 80% because each of the squares equals 4% of the total area. When squares were partially filled with vegetation, a single cover estimate made from the combined the cover within individual squares. For example, if one square was half filled with vegetation, one was a quarter filled, and three squares had only two small blades of grass each, the combination of these would be equal to one full square of cover, or 4%. Percent vegetation cover was estimated as an average value of ten replicates randomly placed within each of the revegetation areas represented by the twelve permanent revegetation monitoring plots. Percent vegetation cover was considered when assessing the overall trajectory and success of riparian revegetation and the potential for erosion and sedimentation. Qualitative notes of general site conditions, including any soil erosion or potential erosion, were also recorded.

3.1.1.3. Photopoint Comparison

Photopoint monitoring was conducted to allow visual qualitative evaluation of changes in revegetation among years (i.e., year 1, 3, and 5 of operations) and thereby aid in interpretation of results from the two quantitative revegetation effectiveness evaluation methods. Photos were taken from the centre of plots, and from specific plot locations at vantage points that overlooked the revegetation area represented by the plot. Standard photographs were taken from 1.3 m above each of the plot's centre facing north (0º), east (90º), south (180º), and west (270º), and of the plot centre. Additional photographs were taken of specific areas where revegetation challenges were identified, or successes were observed, to support professional opinions on site-specific revegetation effectiveness or future revegetation requirements. Photographs were archived to provide documentation of changes in vegetation over time.

3.2. Water Temperature and Air Temperature

3.2.1. Study Design

The Upper Lillooet River and Boulder Creek baseline and operational water and air temperature site names, site elevations, period of record, number of days with valid data, and the percent of the period of record where there are data gaps are summarized in Table 5 and Table 6, respectively. Detailed water and air temperature baseline methodology and data analysis are provided in the aquatic baseline report (Harwood *et al.* 2013,b). Representative photos for each water temperature monitoring site are provided in Appendix C and site locations in the Upper Lillooet River and Boulder Creek are shown on Map 2 and Map 3, respectively.

Baseline water temperature was monitored in the Upper Lillooet River at an upstream control site (ULL-USWQ1; November 2008 to June 2013) and at a lower diversion site (ULL-DVWQ; November 2010 to May 2013) (Table 5, Map 2). Baseline water temperature was monitored in Boulder Creek at an upstream control site (BDR-USWQ; April 2010 to May 2013) and in the diversion reach (BDR-DVWQ; November 2008 to June 2013) (Table 6, Map 3).

Operational monitoring includes two new locations for each facility: one at the tailrace and one downstream of the tailrace. Temperature data are collected at the tailrace to assist in evaluation of potential temperature effects in the downstream reach of the Project. Potential Project effects will be evaluated following completion of five years of temperature monitoring through a BACI analysis.

Operational water temperature monitoring commenced in March 2018 at three monitoring sites in the Upper Lillooet River: upstream site (ULL-USWQ02), at the tailrace (ULL-TAILWQ) and downstream

(ULL-DSWQ). In November 2018, operational monitoring commenced at the lower diversion (ULL-DVWQ01) and at a new upstream site (ULL-USWQ03), which was established due to difficult access to ULL-USWQ02.

Operational water temperature monitoring in Boulder Creek commenced in March 2018 at three monitoring sites located in the lower diversion (BDR-DVWQ), tailrace (BDR-TAILWQ) and downstream (BDR-DSWQ). In September 2018, temperature loggers were installed in Boulder Creek (BDR-USWQ2) and North Creek (NTH-USWQ1) to continue concurrent collection of water temperature data for at least one year of operational monitoring (Table 6). Temperature data loggers that were installed in September 2018 at the upstream site (BDR-USWQ2) were destroyed during storm events, therefore new temperature data loggers were installed on October 11, 2019, resulting in a data gap from September 2018 to October 2019 (Table 6).

In Year 3, concurrent monitoring of water temperature at BDR-USWQ2 and NTH-USWQ1 for a period of one year (October 2019 to October 2020) was completed. The relationship between water temperatures at the two sites will be used to make minor adjustments to the baseline (2010 to 2013) record of late fall to early spring temperatures to represent baseline temperatures more reliably in the upstream reach of Boulder Creek prior to undertaking a BACI analysis at the conclusion of the operational monitoring period.

In the Upper Lillooet River, baseline air temperature was monitored continuously at two sites established in close proximity to the water temperature sites, one upstream (ULL-USAT; April 2010 to May 2013) and one in the lower diversion (ULL-DVAT; April 2010 to May 2013) (Table 5). Operational air temperature data are collected at two sites in the Upper Lillooet River: one in the upstream reach (ULL-USAT01; March 2018 to April 2019, ULL-USAT02; October 2019 to January 2020) and at a site in the downstream reach (ULL-DSAT; March 2018 to October 2020) (Table 5, Map 2). Only two complete months (November and December or 2019) of air temperature data are currently available for ULL-USAT02 due to damage to the sensor at this location. A new sensor was installed in October 2020; on this date it was found that the housing for the sensor was broken. The sensor appears to have been buried in snow in January 2020 collecting data reflecting this (flat around 0°C) until mid-March 2020 after which the sensor began recording a constant temperature of -95°C. In Year 3, data collected at this location are not included in summary statistics due to the truncated data set.

Air temperature in Boulder Creek was collected at one site in the lower diversion (BDR-DVAT) for both baseline (April 2010 to May 2013) and operational monitoring (March 2018 to October 2020) (Table 6, Map 3).

This Year 3 report presents water and air temperature data collected up to October 22, 2020. The operational period of record spans two and a half calendar years (March 2018 to October 2020) and corresponds to Year 1, Year 2, and Year 3 of the monitoring program (Table 5 and Table 6). Baseline water and air temperature data are provided for comparison in the report and for reference in

Appendix D. Project related effects on water temperature will be evaluated using a BACI analysis following five years of data collection as specified in the OEMP (Harwood *et al*. 2017).

Table 5. Summary of water temperature site names, location, period of data record in Upper Lillooet River during baseline (2008 to 2013) and operational monitoring (2018-2020).

Type	Project Phase	Site	UTM Coordinates (10U)		Elevation	Periods of Record		Number of Days on Record	No. of Days with Valid Data	Data Gaps (% Complete)
			Easting	Northing	(masl)[1]	Start Date	End Date			
Water	Baseline	ULL-USWQ1	466,097	5,614,105	666	19-Nov-08	03-Jun-13	1,658	1,653	100
		ULL-DVWQ	468,283	5,612,234	490	12-Nov-10	01-May-13	902	632	70
	Operation	ULL-USWQ02[2]	464,122	5,614,982	684	28-Mar-18	11-Oct-19	563	441	79
		ULL-USWQ03	465,530	5,614,484	673	01-Nov-18	22-Oct-20	722	719	100
		ULL-DVWQ01	468,344	5,611,968	481	01-Nov-18	16-Mar-20	502	500	100
		ULL-TAILWQ	468,423	5,611,670	474	28-Mar-18	22-Oct-20	940	740	82
		ULL-DSWQ	468,601	5,611,202	463	28-Mar-18	22-Oct-20	940	938	100
Air	Baseline	ULL-USAT	466,097	5,614,105	666	07-Apr-10	01-May-13	1,121	1,084	97
		ULL-DVAT	468,375	5,612,158	483	07-Apr-10	01-May-13	1,121	763	69
	Operation	ULL-USAT01	464,141	5,614,996	687	28-Mar-18	11-Apr-19	380	307	81
		ULL-USAT02	468,677	5,611,155	463	24-Oct-19	20-Jan-20	89	87	100
		ULL-DSAT	468,677	5,611,155	463	28-Mar-18	02-Oct-20	920	783	85

[1] Estimated from Google Earth.

[2] Data gap from November 14, 2018 to March 13, 2019 due to low water levels and ice affecting sensors

Table 6. Summary of water temperature site names, location, period of data record in Boulder Creek baseline (2008 to 2013) and operational monitoring (2018-2020).

Type	Project Phase	Site	Elevation (masl)[1]	Periods of Record		Number of Days in Record	No. of Days with Valid Data	Data Gaps in Record (% Complete)
				Start Date	End Date			
Water	Baseline	BDR-USWQ[2]	1,005	22-Apr-10	01-May-13	1,106	1,103	99
		NTH-USWQ1	911	12-Sep-10	01-May-13	963	963	100
		BDR-DVWQ	488	15-Nov-08	06-Jun-13	1665	1,655	99
	Operation	BDR-USWQ2[3]	1,030	24-Sep-18	22-Oct-20	760	376	50
		NTH-USWQ1	911	24-Sep-18	22-Oct-20	760	758	100
		BDR-DVWQ	488	16-Mar-18	01-Oct-20	931	929	100
		BDR-TAILWQ	488	16-Mar-18	22-Oct-20	952	703	77
		BDR-DSWQ	488	16-Mar-18	22-Oct-20	952	950	100
Air	Baseline	BDR-DVAT	490	08-Apr-10	01-May-13	1120	1,120	100
	Operation	BDR-DVAT	490	16-Mar-18	01-Oct-20	931	930	100

[1] Estimated from Google Earth.

[2] Due to groundwater inputs at BDR-USWQ winter data during the baseline period for this site were synthesized from NTH-USWQ1, including: Nov. 26, 2010 to May 21, 2011; Oct. 22, 2011 to April 23, 2012; October 24 to 30, 2012; and Nov. 8, 2012 to April 26, 2013.

[3] Data gap from Sept 24, 2018 to Oct. 11, 2019 due to loss of temperature loggers during storm flows.

3.2.2. Fish Species Distribution

The fish distribution of the Upper Lillooet River has been described in previous baseline monitoring documents and in the OEMP (Harwood *et al.* 2017) (Table 7). The fish species targeted for temperature monitoring in the Upper Lillooet River and Boulder Creek are Bull Trout and Cutthroat Trout with the addition of Coho Salmon for the Upper Lillooet River only. Cutthroat Trout may be present at all temperature monitoring site locations in the Upper Lillooet River and at the diversion and downstream locations on Boulder Creek, while Bull Trout are limited to the diversion and downstream locations of both the Upper Lillooet River and Boulder Creek. Coho Salmon have been detected in the lower diversion and downstream reaches of the Upper Lillooet River.

Bull Trout are the most thermally sensitive species present in both Project areas and this species prefers cooler temperatures overall than other species present. The BC WQG (MOE 2019) for water temperature specify optimum temperature ranges for rearing, spawning, incubation, and migration for these fish species (Table 7) and the applicable guideline range is defined as ± 1°C of the optimum temperature for each life stage.

Table 7. BC WQG optimum temperature range and fish species distribution in the Upper Lillooet River and Boulder Creek (MOE 2019).

Fish Species	Optimum Water Temperature Range (°C)				Fish Presence	Reach
	Spawning	Incubation	Rearing	Migration		
Cutthroat Trout	9.0 - 12.0	9.0 - 12.0	7.0 - 16.0	-	Upper Lillooet River	Upstream, diversion and downstream
					Boulder Creek	Lower diversion and downstream
Bull Trout [1]	5.0 - 9.0	2.0 - 6.0	6.0 - 14.0	-	Upper Lillooet River	Diversion and downstream
					Boulder Creek	Lower diversion and downstream
Coho Salmon [1]	4.4 - 12.8	4.0 - 13.0	9.0 - 16.0	7.2 - 15.6	Upper Lillooet River	Diversion and downstream

The BC WQG for water temperature is ± 1°C outside the optimum temperature range for each life stage.

[1] Bull Trout and Coho Salmon are only present in the lower diversion and downstream reaches of the Upper Lillooet River. They are not present above Keyhole falls.

3.2.3. Quality Assurance/Quality Control

Prior to analysis, temperature data are carefully inspected and QA'd to ensure that any suspect or unreliable data are excluded from data analysis and presentation. Excluded data includes instances where the water temperature sensor was suspected of being out-of-water/dry, affected by snow/ice or buried in sediment.

The accuracy of the TidbiT® temperature readings are evaluated by periodically performing *in-situ* spot temperature measurements and comparing these results to the corresponding data logged with the TidbiT® sensor.

Operational water temperature was recorded at intervals of 15 minutes, using self-contained TidbiT® data loggers. The loggers are accurate to ±0.2°C and have a resolution of 0.02°C. Two TidbiT® loggers were installed on separate anchors at each location. This redundancy ensures availability of data in case one of the loggers malfunctioned or was lost. Air temperature was recorded at intervals of 15 minutes, using self-contained Onset® HOBO®U23-002 Temp/RH sensor (range of 40°C to 70°C, accuracy of ±0.21°C from 0°C to 50°C).

3.2.4. Data Collection and Analysis

Processing of water temperature data was conducted by first identifying and removing outliers as part of a thorough Quality Assurance/Quality Control (QA/QC) process (see Section 3.2.3). After identifying and removing outliers, the records from duplicate loggers were averaged and records from different download dates were combined into a single time-series for each monitoring site. The time series for all sites were then interpolated to a regular interval of 15 minutes (where data were not already logged on a 15-minute interval), starting at the full hour.

Data are presented in plots that were generated from water and air temperature data collected at, or interpolated to, 15-minute intervals. Analysis of the data involved computing the following summary statistics: monthly statistics (mean, minimum, and maximum water temperatures for each month of record, as well as differences in water temperature among sites), days with extreme mean daily temperature (i.e., >18°C and <1°C), days with exceedances of the minimum and maximum Bull Trout temperature thresholds, the length of the growing season, accumulated thermal units in the growing season (e.g., degree days), hourly rates of temperature change, and mean weekly maximum temperature (MWMxT). These statistics are defined and described in Table 8 and applicable guidelines are discussed in the following section.

After Year 2 reporting, historic data (including baseline) underwent updated cleaning to ensure it was processed according to current standards. As a result, some revisions to historic data were made to improve accuracy and values presented herein may differ from those presented in previous reports. Some of the changes included:

- Hourly Rates of Water Temperature Change - the percentage of records calculated as the total # of valid hourly change records with a rate of change >1ºC, whereas some historical data included the total # of temperature records, rather than valid records.
- Mean Weekly Maximum Temperature (MWMxT) - changes from previous versions of this analysis include:

  - the inclusion of a cut-off whereby a day is excluded from the calculation if it does not include data during the warmest period of the day. By default, a day is excluded when it does not have at least one hourly measurement between 11:00 and 18:00.
  - for growing season, a "week" was calculated as a centred average (i.e., three days before and three days after the day for which MWMxT is being calculated). Therefore, the computed start and end date of the growing season are three days later/earlier, respectively.

- Growing Season Statistics - Rules for the length of gaps that can be interpolated were applied to historic data; the maximum gap cannot exceed 14 days. In addition, start and end dates for weekly averages are defined in terms of calendar weeks (the start/end dates reported are the start of the calendar week containing the day the threshold was crossed), resulting in a change in start/end dates of ± 3 days. In some historic data, running weekly averages were calculated, and the start/end dates were defined as the date the threshold was crossed minus three days (i.e., a centered weekly average).
- Further review of operational data collected at the upstream sites in the Upper Lillooet River has resulted in the exclusion of previously reported data collected at ULL-USWQ02 between November 14, 2018 to March 13, 2019 due to the sensors likely being buried in snow/ice.

3.2.5. Applicable Guidelines

The water temperature BC Water Quality Guidelines (BC WQG) for the protection of aquatic life (as per Oliver and Fidler 2001, MOE 2019) are discussed below.

Hourly Rates of Water Temperature Change

Rapid changes in heating or cooling of water temperature can affect fish growth and survival (Oliver and Fidler 2001). Hourly rates of change in water temperature were compared to the BC WQG, which specifies that the hourly rate of water temperature change should not exceed ±1.0°C/hr (MOE 2019).

Daily Temperature Extremes

Extreme cold or warm temperatures are monitored as part of the water temperature component. The number of days when the daily mean temperature was <1°C was calculated, along with the number of days when the daily mean temperatures were >18°C and >20°C. The Upper Lillooet River and Boulder Creek are cool streams where maximum temperatures recorded to date did not exceed 15°C, therefore the number of days of water temperatures >18°C and >20°C are not required. The maximum optimum temperature for the fish species present in the Project area is 16°C (Coho Salmon and Cutthroat Trout rearing life stage, Table 7).

Mean Weekly Maximum Temperature (MWMxT)

The MWMxT is an important indicator of prolonged periods of cold and warm water temperatures that fish may be exposed to. The BC WQG states "Where fish distribution information is available, then mean weekly maximum water temperatures should only vary by ±1.0°C beyond the optimum temperature range of each life history phase for the most sensitive salmonid species present" (Oliver and Fidler 2001, MOE 2019). Accordingly, MWMxT values were compared to the optimum temperature ranges for the fish species present based on the life history and periodicity (Table 7).

Within each life history period, the completeness of the temperature data record (% complete) is calculated and results are only included if at least 50% of the data for the period are available. The minimum and maximum MWMxT values, % data within the optimum range, and % exceedance of ±1.0°C of the optimal temperature range is calculated for each life history period to evaluate the suitability of the temperature regime for each fish species/reach during baseline and operational monitoring (Table 7, Table 8).

Table 8. Description of water temperature metrics and methods of calculation.

Metric	Description	Method of Calculation
Water temperature	Hourly or 15 minute data	Data (interpolated to 15 minute intervals where necessary) presented in graphical form.
Monthly statistics	Mean, minimum, and maximum on a monthly basis	Calculated from 15 minute data (interpolated where necessary) and presented in tabular format.
Degree days in growing season	The beginning of the growing season is defined as the beginning of the first week that mean stream temperatures exceed and remain above 5°C; the end of the growing season was defined as the last day of the first week that mean stream temperature dropped below 4°C (as per Coleman and Fausch 2007).	Daily mean water temperatures were summed over this period (i.e., from the first day of the first week when weekly mean temperatures reached and remained above 5°C until the last day of the first week when weekly mean temperature dropped below 4°C).
Number of Days of Extreme Daily Mean Temperature	Daily average temperature extremes for all streams	Total number of days with daily mean water temperature >18°C, >20°C, and <1°C.
Number of Days of Exceedance	Daily maximum and minimum temperature thresholds for streams with Bull Trout / Dolly Varden	# days maximum daily temperature is >15°C; # days maximum incubation temperature is >10°C; # days minimum incubation temperature is <2°C; and # days maximum spawning temperature is >10°C.
MWMxT (Mean Weekly Maximum Temperature)	Mean, minimum, and maximum on a running weekly (7 day) basis	Mean of the warmest daily maximum water temperature based on hourly data for 7 consecutive days; e.g., if MWMxT = 15°C on August 1, 2008, this is the mean of the daily maximum water temperatures from July 29 to August 4, 2008; this is calculated for every day of the year.

3.2.6. Frazil Ice

A protocol was established in December 2017 to monitor frazil ice conditions in the Upper Lillooet River and Boulder Creek diversion reaches and the potential effects of frazil ice formation on fish habitat availability (Harwood *et al.* 2017). An automated alarm system was set up that triggers an email alert to Ecofish QPs when mean daily air temperatures of -5ºC or lower are forecasted for five consecutive days at the Pemberton Airport and/or Callaghan Valley meteorological stations. After three consecutive days of mean daily air temperatures of -5ºC or lower, as measured at either station, if the HEFs are still operating, an Ecofish QP notifies the operators and requests photographs of the diversion reach taken from established photo monitoring points in the lower diversion reach of each HEF to determine if frazil ice is visible. If there is evidence of frazil ice and the HEFs remain operational, a crew is mobilized to site to perform assessments of the percentage of fish holding habitat displaced by frazil ice at established frazil ice monitoring sites. A total of five monitoring sites have been established in the diversion reach of each HEF (Map 4), located either in stranding sensitive monitoring sites (SSMSs) or closed-site electrofishing sites where fish are known to overwinter.

After a field survey has been conducted, an Ecofish QP reviews the results and provides a written communication to the Project Environment and Operations teams. The communication includes a professional evaluation of the severity of frazil ice accumulations and recommended actions, which may be to cease monitoring, continue monitoring at a defined schedule; or shut-down the HEF until mean daily air temperatures increase above -5ºC and/or a follow up survey indicates that the risk of additional ice formation has abated. This report includes Year 3 air temperature data, photographs, and frazil ice assessments completed in 2020.

3.3. Fish Community

3.3.1. Adult Migration and Distribution

3.3.1.1. Bull Trout Angling Surveys

Angling surveys were conducted during the Bull Trout spawning migration window (September 15 to October 21 in 2020) in the downstream and diversion reaches, and at the tailrace, of both the Upper Lillooet River and Boulder Creek, and in a section of North Creek (which serves as a reference creek). The angling survey area on Boulder Creek included approximately 900 m downstream and 300 m upstream from the powerhouse, and the tailrace. Angling effort upstream of the powerhouse was limited due to the safety concerns associated with accessing the entrenched canyon section. The fish bearing reach on Boulder Creek is considered to extend from the confluence with the Upper Lillooet River upstream 2.64 km, with approximately 1.7 km of the diversion reach accessible to fish. The angling survey area on the Upper Lillooet River included approximately 500 m upstream and downstream of the powerhouse, and the tailrace. The entire length of the diversion reach of Upper Lillooet River is fish bearing, but Bull Trout distribution is limited by Keyhole Falls located approximately 3 km upstream of the Upper Lillooet River HEF powerhouse. The angling survey area on North Creek included an approximately 600 m section, 1 km upstream from the confluence with the Upper Lillooet River. Angling surveys were conducted at established monitoring sites (shown in Map 5), in high-grade Bull Trout habitat, that had been identified by experienced fisheries technicians. Each survey was conducted by two experienced anglers, with effort scaled to account for the fishable area of each site, but for no less than 0.75 rod hours per site.

Angling was primarily conducted using roe as bait under a float as this proved to be most effective during baseline monitoring. All captured fish were anaesthetized prior to processing. During processing, fish were identified to species, weighed (±0.1 g for fish ≤ 200 g, ±1 g for fish > 200 g), measured for fork length (±1 mm), and photographed. Scale samples were collected from subsamples of any Cutthroat Trout captured during angling targeting Bull Trout, and fin ray samples were collected from all Bull Trout ≥100 mm in length. Small fin clip samples were also collected from captured fish that were preserved in 95% ethanol and archived for future analysis if required.

All captured fish were scanned for passive integrated transponder (PIT) tags. If no PIT tags were detected, a PIT tag was implanted into the body cavity of each fish greater than approximately 60 mm in length to allow assessment of movement in future years. After processing, fish were placed in a bucket of fresh water to recover. Upon recovery, fish were released back into the sample site. Relevant site characteristics and conditions were also recorded during angling surveys.

Visual assessments of the potential for fish passage and upstream access were conducted during angling surveys during the spawning migration period on the lower 1.2 km of Boulder Creek. As crews were moving upstream, the potential for fish passage at critical locations identified during baseline studies (Faulkner *et al.* 2011) were visually assessed for connectivity at the observed flows and connectivity was estimated for maximum flows (determined from the high-water points on banks). Visual assessment of fish passage and upstream access was also assessed during angling surveys for approximately 500 m upstream of the Upper Lillooet River HEF powerhouse.

3.3.1.2. Tributary Bank Walk Bull Trout Spawner Surveys

Bull Trout migration, distribution, and spawning was also monitored using bank walk spawner surveys on three separate occasions (between September 15 and October 21) in fall of 2020 at two reference tributaries of the Upper Lillooet River as specified in the OEMP (Harwood *el at.* 2017): the tributary at km 29.2 of the Lillooet River (29.2 km Tributary) and Alena Creek. These reference tributaries are being monitored to help assess potential confounding effects of the Capricorn/Meager slide in August 2010 on results of the monitoring program in the Upper Lillooet River and Boulder Creek. The additional monitoring allows an assessment of changes to the fish populations in the Project and reference streams by analyzing temporal trends in metrics to identify the recovery rate of both the Project and reference streams from the slide. At 29.2 km Tributary and Alena Creek, bank walk spawner surveys were conducted by walking along the shore during the Bull Trout spawning period and recording the number of spawning fish, any carcasses, and redds.

3.4. Wildlife Species Monitoring

3.4.1. Harlequin Ducks

Harlequin Duck monitoring was conducted at the Upper Lillooet River HEF intake and powerhouse through vantage point surveys (spot checks) (RIC 1998) along with the recording and compilation of incidental observations. The standardized protocols used in other years (Appendix E) were followed for some survey aspects but not for others. Specifically, protocols were followed for survey timing and frequency. Spot checks were conducted during two time periods when Harlequin Ducks are most likely to be observed on the breeding stream: the pre-incubation period (month of May) when Harlequin Duck pairs are on the river ("pair" survey), and the brood-rearing period (late July to late August) when males have departed from breeding streams and the female is rearing her brood ("brood" survey). In Year 3, spot checks were conducted at the intake and the powerhouse on May 12, 18, and 26, and on August 5, 10, and 15. However, spot checks were done with the use of zoomable surveillance cameras from a room inside the powerhouse, rather than in person with binoculars or spotting scope from the vantage points specified in the protocols (Appendix E). The fields of view of the two surveillance cameras encompassed the entire tailrace and head pond, respectively.

Data collected during spot checks included survey date, location, time, and number of individuals observed, as well as age, sex, and behaviour (e.g., feeding, flying, group or pair behaviour), if relevant (i.e., Harlequin Ducks were observed). Any comments on weather conditions or survey limitations were recorded, and photos were taken of any occurrence observations. Observations of other waterbirds seen during surveys were also recorded. Incidental Harlequin Duck observations were also recorded opportunistically by plant operations staff, consulting biologists, and technicians throughout the year.

3.4.2. Species at Risk & Regional Concern

All incidental observations of wildlife species at risk or of regional concern documented by Innergex and Ecofish personnel within the Project area in Year 3 were recorded and were compiled according to provincial format to facilitate data sharing. Incidental observations also include detections from the two remote infrared wildlife cameras (ULL-CAM02 and ULL-CAM15) left in place following the completion of the Mountain Goat mitigation effectiveness monitoring component associated with the ULR HEF portal. Incidental wildlife observations detected by the wildlife cameras in the vicinity of the Boulder Creek HEF intake installed for Mountain Goat mitigation effectiveness monitoring are summarized along with detections of predators by those cameras (in Section 4.5.3.1).

3.5. Wildlife Habitat Monitoring

3.5.1. Habitat Restoration – Amphibian Habitat

A spot check of instream and riparian Coastal Tailed Frog habitat at the Upper Lillooet River HEF penstock crossing (ULL-ASTR04) was conducted in Year 3 to assess the effectiveness of the substrate addition completed in 2019 and evaluate potential exposure of geotextile. The spot check was conducted on August 24, 2020 and involved inspection of the location where geotextile had been exposed in 2019.

3.5.2. Habitat Restoration – Mammal Habitat

Mammal habitat restoration compliance monitoring for Grizzly Bears, Moose, and Mule Deer involved confirming compliance with prescribed habitat restoration measures, which included confirmation of the presence and adequacy of vegetated screens at established restoration monitoring sites (between active FSR and the transmission line RoW where the RoW passes through Grizzly Bear WHA 2-399 or other high value (Class 1 and Class 2) Grizzly Bear habitat and through Moose or Mule Deer UWR). Monitoring was conducted from August 24 to August 25, 2020 at the 23 monitoring sites (Table 9, Map 8, Map 9, Map 10, Map 11) where reassessment in Year 3 had been recommended (see Year 1 report; Regehr *et al.* 2019). Some monitoring sites had been established to monitor requirements for a single species and others applied to more than one species.

Assessment of the requirements for vegetated screens at restoration monitoring sites in high value mammal habitat required confirmation of screen presence as well as assessment of screen characteristics at each site. This involved taking three sets of measurements of screen height and width and three sets of estimated percent coverage of visibility through the screen, and generating an average of each measure/estimate for the vegetated screen for each site. Photographs were also taken to photo-document screen appearance and condition and allow visual comparison to Year 1 results.

Table 9. Locations of mammal vegetated screen monitoring sites that required reassessment in Year 3 and dates of reassessments.

Site	Species and Habitat[1]	Date	UTM Coordiantes (Zone 10U)	
			Easting	Northing
ULH-MAMCM01	Grizzly Bear - High Value	24-Aug-2020	468746	5611295
ULH-MAMCM02	Grizzly Bear - High Value	24-Aug-2020	468915	5611147
ULH-MAMCM04B	Grizzly Bear - High Value	24-Aug-2020	476857	5603920
ULH-MAMCM06	Grizzly Bear - High Value Mule Deer - UWR	24-Aug-2020	480898	5603041
ULH-MAMCM07	Grizzly Bear - High Value Mule Deer - UWR	24-Aug-2020	481528	5602826
ULH-MAMCM08	Mule Deer - UWR	24-Aug-2020	481796	5602741
ULH-MAMCM09	Grizzly Bear - High Value Mule Deer - UWR	24-Aug-2020	482647	5602427
ULH-MAMCM10	Mule Deer - UWR	24-Aug-2020	482954	5602219
ULH-MAMCM11	Mule Deer - UWR	24-Aug-2020	483369	5601923
ULH-MAMCM12	Moose - UWR	24-Aug-2020	485810	5600967
ULH-MAMCM14	Grizzly Bear - WHA 2-399 Moose - UWR	24-Aug-2020	487543	5599229
ULH-MAMCM17	Grizzly Bear - South Lillooet River FSR	24-Aug-2020	491512	5597274
ULH-MAMCM18	Grizzly Bear - South Lillooet River FSR	24-Aug-2020	491964	5597244
ULH-MAMCM19	Grizzly Bear - South Lillooet River FSR	24-Aug-2020	492224	5596959
ULH-MAMCM20	Mule Deer - UWR	25-Aug-2020	499728	5591270
ULH-MAMCM21	Grizzly Bear - High Value Mule Deer - UWR	25-Aug-2020	499872	5591204
ULH-MAMCM22	Grizzly Bear - High Value	25-Aug-2020	500113	5591109
ULH-MAMCM23	Grizzly Bear - High Value	25-Aug-2020	501095	5590537
ULH-MAMCM24	Grizzly Bear - High Value Mule Deer - UWR	25-Aug-2020	501419	5590366
ULH-MAMCM25	Grizzly Bear - High Value Mule Deer - UWR	25-Aug-2020	502437	5589574
ULH-MAMCM26	Grizzly Bear - High Value Mule Deer - UWR	25-Aug-2020	503208	5588834
ULH-MAMCM27	Grizzly Bear - High Value	25-Aug-2020	507825	5577642
ULH-MAMCM28	Grizzly Bear - High Value	25-Aug-2020	507856	5577626

[1] High value Grizzly Bear habitat is considered as Class 1 or Class 2 as identified by habitat suitability modelling (Leigh-Spencer *et al.* 2012) and confirmed in the field (Leigh-Spencer *et al.* 2013).

3.5.3. Mitigation Effectiveness – Mountain Goats at Boulder Creek

3.5.3.1. Public Access Monitoring

The effectiveness of the gate on the access road to the Boulder Creek HEF intake in preventing public access into the upper Boulder Creek watershed and potentially into the Mountain Goat winter range (UWR u-2-002 UL 12) during winter (November 1 to June 15 as per Project's EAC) is being monitored through the strategic placement of three remote infrared cameras along the Boulder Creek HEF intake access road (Map 2). The first camera was placed at the gate (BDR-CAM03), and the other two cameras (BDR-CAM01 and BDR-CAM02) were installed along the access road, past the gate towards the intake (Map 2). Table 10 provides a summary of the locations and functionality of these three cameras. It should be noted that although all three cameras had periods where they were not functional, at least one of the three cameras was functional during the entire monitoring period.

3.5.3.2. Predator Monitoring

Potential changes in the presence and behaviour of Mountain Goat predators due to new access into the winter range (UWR u-2-002 UL 12) was monitored in Year 3 through the use of remote infrared cameras. Although systematic winter ground-based surveys (snow-tracking surveys along transects) were specified in the Project's OEMP, these ground-based surveys were discontinued partway through Year 1 monitoring (in November 2018; Regehr *et al.* 2019) due to safety concerns in the vicinity of the Boulder Creek HEF intake and access road during winter (Newbury *et al.* 2018). To compensate, four remote infrared cameras were installed along the systematic winter ground-based survey transects on November 30, 2018 (Map 2, Table 10). Thus, predator monitoring was conducted through the three cameras used for gate effectiveness monitoring (BDR-CAM01, BDR-CAM02, BDR-CAM03) (note that this differs slightly from what is specified in the OEMP because one of the previous camera locations became unsuitable), along with four additional cameras that are located along survey transects BDR-SNTR02 (BDR-CAM05 and BDR-CAM06) and BDR-SNTR03 (BDR-CAM07 and BDR-CAM08) (Table 10, Map 2). Another camera (BDR-CAM04) had also been installed near the top of transect BDR-SNTR03 since May 8, 2018 and this was also used for predator monitoring. All photographs taken by the remote infrared cameras during the Year 3 monitoring period were viewed and data were compiled.

The Year 3 post-construction monitoring period for which data are presented in this report began on February 25, 2020, when the Year 2 monitoring period ended, and ended on December 23, 2020, when the last data from Year 3 camera monitoring were downloaded. Results from monitoring for Year 1 (conducted from December 21, 2017 to January 17, 2019) are provided in the Year 1 report (Regehr *et al.* 2019), and those from monitoring for Year 2 (conducted from January 17, 2019 to February 25, 2020) are provided in the Year 2 report (Harwood *et al.* 2021). Baseline data from the pre-construction period (November 2010 to April 2014) are presented in the wildlife baseline monitoring report (Regehr *et al.* 2016).

Table 10. Remote infrared camera locations at the Boulder Creek HEF intake and intake access road and camera functionality during the Year 3 monitoring period (February 25 to June 15, 2020 and November 1 to December 23, 2020).

Camera	Location	UTM Coordinates (Zone 10U)		Functionality during Monitoring Period (February 25 to June 15, 2020 and November 1 to December 23, 2020)
BDR-CAM01	Viewing the access road, approximately 300 m from the Boulder Creek HEF intake.	473222	5611166	Camera was not functional from March 6 to March 12, 2020. Moisture in the camera caused the batteries to die.
BDR-CAM02	Viewing the Boulder Creek HEF intake access road.	472876	5610976	Camera was not functional from March 26 to May 12, 2020, because the tree the camera was mounted on fell down.
BDR-CAM03	Gate on the access road to the Boulder Creek HEF intake.	471943	5610609	Functional for the entire period
BDR-CAM04	Above the Boulder Creek HEF intake access road, along an old logging road at the top of BDR-SNTR03.	472699	5610993	Functional for the entire period.
BDR-CAM05	In an open area along transect BDR-SNTR02.	473323	5611759	Functional for the entire period; however, between April 23 and May 12, 2020, the angle of the camera pointed above the intended area because snowmelt caused the tree to move. The camera was repositioned to again focus on the intended area on May 12, 2020.
BDR-CAM06	At the top of transect BDR-SNTR02.	473198	5611474	Functional for the entire period. The camera lens was partially obstructed from October 22- December 23, 2020 due to tree bark that had peeled down over the camera
BDR-CAM07	Along transect BDR-SNTR03.	473092	5611314	Functional for the entire period.
BDR-CAM08	Along the upper road section of transect BDR-SNTR03.	472821	5611090	Functional for the entire period. The camera lens was partially obstructed from a branch from April 19 to May 12, 2020.

4. RESULTS

4.1. Aquatic and Riparian Habitat

4.1.1. Riparian Revegetation Assessment

As documented in more detail in the sub-sections below, in Year 3, density targets of 1,200 tree stems/ha and 2,000 shrub stems/ha were met, on average, in all revegetation areas represented by permanent riparian revegetation monitoring plots. Overall, stem densities increased in all except one (ULL-PRM09) of the twelve plots. Although there is a wide range of stem densities in the plots in accordance with their successional stage or other factors, the trajectory of results indicates that the plots are revegetating well and there were no significant problems noted. Overall, Year 3 monitoring results indicate that site conditions are generally good (e.g., adequate soil retention, adequate amounts of topsoil), and woody vegetation is becoming established. In addition, the average vegetated ground cover was approximately 24%, which represents an increase relatively to previous years for all revegetation areas except the area represented by ULL-PRM09. Although ground cover remains sparse, it has been increasing. Results from photopoint monitoring (Appendix F, Appendix G) concur with these results. Bull thistle (*Cirsium vulgare*) was observed and removed from site in Year 3.

4.1.1.1. Density, Species Composition, and Survival of Woody Vegetation

In Year 3 of the five-year monitoring program, average tree and shrub stem densities (12,333 ± 8,148 tree stems/ha and 4,883 ± 1,504 shrub stems/ha) estimated from all permanent revegetation monitoring plots combined exceeded density targets of 1,200 tree stems/ha and 2,000 shrub stems/ha (Table 11). Although there was substantial variability in tree and shrub stem density among plots (counts of living tree and living shrub stems per plot ranged from 14 to 295 and 4 to 54, respectively; Table 11), the target for trees was met at all plots and the target for shrubs was met at all except one plot (ULL-PRM03; Table 12). As in Year 1, stem densities were highest overall within the Upper Lillooet River HEF powerhouse plots, especially in ULL-PRM10, which had a much higher tree density than the other plots due to abundant natural regeneration of black cottonwood (*Populus balsamifera ssp. trichocarpa)* and western hemlock (*Tsuga heterophylla*). Three dead and 1,033 living stems were observed in all plots combined. Although it was not possible to determine if mortalities are of planted stock *per se*, the overall proportion of dead stems was low (<1%), suggesting the target of 80% survival has been met (DFO and MELP 1998, Harwood *et al.* 2017). In general, this result suggests woody vegetation is establishing successfully.

At the Boulder Creek HEF powerhouse (plot BDR-PRM01), the total woody stem density was estimated at 15,000 stems/ha, which increased from the 4,800 stems/ha reported in Year 1. Most woody stems were trees (12,400 stems/ha) and a smaller proportion were shrubs (2,600 stems/ha; Table 12). Black cottonwood stem numbers increased from from zero in Year 1 to 34 in Year 3, while coastal Douglas-fir (*Pseudotsuga menziesii*) increased from one stem to 12 stems (Figure 1).

At the ULR HEF intake, the average density of living woody stems was estimated at 10,000 stems/ha (6,933 tree stems/ha, 3,067 shrub stems/ha), based on the three permanent monitoring plots combined (ULL-PRM01, ULL-PRM02 and ULL-PRM03, Table 12). This was an increase from an average of 3,000 stems/ha in Year 1. In Year 3, increases in red alder (*Alnus rubra*) growth was the primary cause of the increase in overall tree stem density, while black cottonwood stem densities remained similar to Year 1 (Table 13; Figure 2, Figure 3). In Year 3, an unidentified willow species (*Salix* sp.) was found in all three plots, increasing shrub densities relative to Year 1. Estimated tree stem densities for all three plots were above the 1,200 stem/ha target, and estimated shrub stem densities were above the 2,000 stem/ha target for all but one plot (ULL-PRM03). Although estimated shrub density remained below the target in ULL-PRM03, it doubled to 800 stems/ha, from 400 stems/ha in Year 1, and no mortality was observed (Table 11, Table 12, Figure 4). Additional planting occurred in the vicinity of these permanent monitoring plots in October of 2018, although the planting did not specifically align with the plots (Barker 2019). Survival of those plantings was assessed in 2019 and was deemed to be acceptable in most sites, although additional planting was recommended at three of the sites (Barker 2020).

Along the ULR HEF penstock, the average density of living woody stems was estimated at 11,467 stems/ha (5,400 tree stems/ha, 3,833 shrub stems/ha) based on six permanent monitoring plots combined (Table 12). Estimated tree and shrub stem densities in all the plots exceeded the target densities. In Year 1, ULL-PRM08 was the only plot with tree stem densities below the target. Black cottonwood regeneration was primarily responsible for an increase in stems in ULL-PRM08, such that estimated stem densities increased from 800 stems/ha in Year 1 to 6,400 stems/ha in Year 3 (Figure 5). Although stem density remained above target in ULL-PRM09 in Year 3, numbers of stems in this plot decreased from Year 1, due mainly to a decrease in the number of black cottonwood stems. However, the red alder stem count increased, and revegetation was noted to be doing well, particularly along the stream edge (Table 13, Figure 6). Overall, planted stock and natural regeneration appeared healthy in the ULR HEF Penstock sites. In Year 1 at ULL-PRM07, the planted red cedars (*Thuja plicata*) appeared stressed, but this was not noted in Year 3 (Figure 7).

At the Upper Lillooet powerhouse, average tree stem density was higher than at other locations, averaging 46,400 stems/ha for the two plots combined (ULL-PRM10 and ULL-PRM11) (Table 12, Figure 8). This was due to high tree stem density (41,200 stems/ha), with abundant natural regeneration of black cottonwood in both plots, as well as western hemlock in ULL-PRM10 (Table 13). Average shrub stem density (5,200 stems/ha) was more similar to other locations.

A total of 17 species were observed within the plots (6 tree and 11 shrub species) during Year 3 monitoring (Table 13). The tree species were black cottonwood, coastal Douglas-fir, red alder, western hemlock, western redcedar (*Thuja plicata*), and lodgepole pine (*Pinus contorta var. latifolia*). Shrub species were black raspberry (*Rubus leucodermis*), kinnikinnick (*Arctostaphylos uva-ursi*), Nootka rose (*Rosa nutkana*), red-osier dogwood (*Cornus stolonifera*), salmonberry (*Rubus spectabilis*), thimbleberry (*Rubus parviflorus*), black huckleberry (*Vaccinium membranaceum*), false azalea (*Menziesia ferruginea*), Oregon grape (*Mahonia sp.*), western mountain-ash (*Sorbus scopulina*), and willow (*Salix sp*).

The number of species per plot ranged from six (ULL-PRM05 and ULL-PRM01) to 11 (BDR-PRM01), with a median of 7.5 (Table 13). Black cottonwood was the most abundant tree species (overall average estimated density of 7,317 stems/ha (± 4,960)) and was also found in every plot including BDR-PRM01, where it was absent in Year 1. Western hemlock was the second most abundant tree species (overall average estimated density of 1,833 stems/ha (± 3,001)) and was found in six of the 12 plots. Black raspberry was the most abundant shrub species (overall average estimated density of 2,233 stems/ha (±1,486)) and was found in seven of 12 plots (Table 13). Bull thistle was pulled from both ULL-PRM08 and ULL-PRM06 (Table 12). The identification of bull thistle was done in the office using photos, after Year 3 field work was completed.

Table 11. Numbers of living and dead woody stems within twelve permanent revegetation monitoring plots (50 m^2) in 2020.

Location	Permanent Monitoring Plot	Count of Woody Vegetation Stems within Plot			
		Live Trees	Live Shrubs	Total Live	Total Dead
Boulder Creek HEF Powerhouse	BDR-PRM01	62	13	75	0
Upper Lillooet River HEF Intake	ULL-PRM01	33	22	55	0
	ULL-PRM02	21	20	41	1
	ULL-PRM03	50	4	54	0
Upper Lillooet River HEF Penstock	ULL-PRM04	24	54	78	1
	ULL-PRM05	46	31	77	0
	ULL-PRM06	23	48	71	0
	ULL-PRM07	23	12	35	0
	ULL-PRM08	32	17	49	0
	ULL-PRM09	14	20	34	0
Upper Lillooet River HEF Powerhouse	ULL-PRM10	295	30	325	0
	ULL-PRM11	117	22	139	1
Mean		61.67	24.42	86.08	0.25
Standard Deviation		78.58	14.50	80.40	0.45
Standard error of the mean		22.68	4.19	23.21	0.13
t-value_90%		1.7959	1.7959	1.7959	1.7959
Confidence Interval		40.74	7.52	41.68	0.23
2020 Expected Density (stems/ha)		**12,333**	**4,883**	**17,217**	**50**
2020 Confidence Interval (± stems/ ha)		**8,148**	**1,504**	**8,336**	**47**
2018 Expected Density (stems/ha)		**7,317**	**2,817**	**10,133**	**117**
2018 Confidence Interval (± stems/ ha)		**7,073**	**883**	**7,377**	**150**

Table 12. Estimated vegetation density within twelve permanent revegetation monitoring plots and percent vegetation cover within the associated riparian revegetation areas in 2020.

Location	Permanent Monitoring Plot	Estimated Tree Vegetation Density (stems/ha)	Estimated Shrub Vegetation Density (stems/ha)	Total Estimated Woody Vegetation Density (stems/ha)	Estimated Vegetation Cover (%)	Comments
Boulder Creek HEF Powerhouse	BDR-PRM01	12,400	2,600	15,000	30	Planted stock is thriving, and there is moderate red alder and herbaceous regeneration.
Mean		*12,400*	*2,600*	*15,000*	*30*	
Upper Lillooet River HEF Intake	ULL-PRM01	6,600	4,400	11,000	55	There is abundant regeneration of grasses, and moderate regeneration of red alder and willow species.
	ULL-PRM02	4,200	4,000	8,200	13	Some western redcedars look stressed, but are still alive, and the Douglas-fir trees appear healthy. There is moderate regeneration of herbaceous plants, and overall woody stem regeneration has improved from 2018.
	ULL-PRM03	10,000	800	10,800	8	Planted stock is thriving, and there is abundant red alder growth with limited herbaceous regeneration.
Mean		*6,933*	*3,067*	*10,000*	*25*	
Upper Lillooet River HEF Penstock	ULL-PRM04	4,800	10,800	15,600	27	Good survival of planted stock, and most conifers are 1 - 1.5 m tall. There is excellent woody stem regeneration with limited herbaceous growth.
	ULL-PRM05	9,200	6,200	15,400	29	Good natural regeneration overall, with abundant red alder regeneration.
	ULL-PRM06	4,600	9,600	14,200	31	Good survival of plant stock, and good natural regeneration of woody stems. Large woody debris is present throughout the site. Invasive thistle species pulled from site.
	ULL-PRM07	4,600	2,400	7,000	15	All planted stock is alive, and thriving. Moderate natural regeneration of herbaceous plants in approximately 3/4 of the site. Red alder is thriving.
	ULL-PRM08	6,400	3,400	9,800	23	Planted stock is healthy and growing well, with a very good survival rate. There is limited natural regeneration of herbaceous plants. Invasive thistle species pulled from site.
	ULL-PRM09	2,800	4,000	6,800	8	Planted stock is thriving. There is limited herbaceous regeneration, and abundant red alder and willow growth along the stream edge, on both river-left and river-right.
Mean		*5,400*	*6,067*	*11,467*	*22*	
Upper Lillooet River HEF Powerhouse	ULL-PRM10	59,000	6,000	65,000	28	Planted stock is thriving, and conifers are 1 - 1.5 m tall. There is abundant natural regeneration, particularly conifers and black cottonwood.
	ULL-PRM11	23,400	4,400	27,800	16	Planted stock is surviving successfully. There is moderate regeneration of black cottonwood, and limited herbaceous regeneration.
Mean		*41,200*	*5,200*	*46,400*	*22*	

Table 13. Number of trees and shrubs by species in the twelve permanent revegetation monitoring plots in 2020.

Location	Permanent Monitoring Plot	Trees						Shrubs												*Total*
		black cottonwood (*Populus balsamifera ssp. trichocarpa*)	coastal Douglas-fir (*Pseudotsuga menziesii var. menziesii*)	lodgepole pine (*Pinus contorta var. latifolia*)	red alder (*Alnus rubra*)	western hemlock (*Tsuga heterophylla*)	western redcedar (*Thuja plicata*)	black huckleberry (*Vaccinium membranaceum*)	black raspberry (*Rubus leucodermis*)	false azalea (*Menziesia ferruginea*)	Kinnikinnick (*Arctostaphylos uva-ursi*)	Oregon grape (*Mahonia sp.*)	Nootka rose (*Rosa nutkana*)	red-osier dogwood (*Cornus stolonifera*)	salmonberry (*Rubus spectabilis*)	thimbleberry (*Rubus parviflorus*)	Huckleberry (*Vaccinium sp.*)	western mountain-ash (*Sorbus scopulina*)	willow (*Salix sp.*)	
Boulder Powerhouse	BDR-PRM01	34	12	6	5	4	1	0	0	0	1	0	0	1	3	7	0	0	1	75
Upper Lillooet Intake	ULL-PRM01	11	0	0	21	1	0	3	0	0	0	0	0	0	1	0	0	0	18	55
	ULL-PRM02	8	4	0	4	0	5	0	8	0	0	0	0	0	0	0	0	1	11	41
	ULL-PRM03	13	6	0	28	1	2	0	0	0	1	0	1	0	0	0	0	0	2	54
Upper Lillooet Penstock	ULL-PRM04	15	6	0	0	0	3	0	47	0	0	0	0	3	0	1	0	0	3	78
	ULL-PRM05	36	9	0	1	0	0	0	21	0	0	0	0	0	0	1	0	0	9	77
	ULL-PRM06	19	1	0	0	1	2	0	15	0	1	2	0	0	0	30	0	0	0	71
	ULL-PRM07	6	9	0	1	0	7	0	0	0	1	0	0	0	0	10	0	0	1	35
	ULL-PRM08	25	6	0	1	0	0	1	3	1	4	0	2	3	0	3	0	0	0	49
	ULL-PRM09	4	0	0	10	0	0	0	0	0	2	0	2	4	3	2	0	0	7	34
Upper Lillooet	ULL-PRM10	159	10	0	6	101	19	0	22	0	1	0	0	0	0	0	0	0	7	325
Powerhouse	ULL-PRM11	109	2	0	0	2	4	0	18	0	0	0	0	3	0	0	0	0	1	139
Mean		36.6	5.4	0.5	6.4	9.2	3.6	0.3	11.2	0.1	0.9	0.2	0.4	1.2	0.6	4.5	0.0	0.1	5.0	86.1
Standard Deviation		47.84	4.08	1.73	9.10	28.94	5.35	0.89	14.33	0.29	1.16	0.58	0.79	1.59	1.16	8.64	0.00	0.29	5.56	80.40
Standard error of the mean		13.81	1.18	0.50	2.63	8.36	1.54	0.26	4.14	0.08	0.34	0.17	0.23	0.46	0.34	2.49	0.00	0.08	1.60	23.21
t-value_90%		1.7959	1.7959	2.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959	1.7959
Confidence Interval		24.80	2.11	1.40	4.72	15.01	2.77	0.46	7.43	0.15	0.60	0.30	0.41	0.82	0.60	4.48	0.00	0.15	2.88	41.68
2020 Expected Density (stems/ha)		7,317	1,083	100	1,283	1,833	717	67	2,233	17	183	33	83	233	117	900	0	17	1,000	17,217
2020 Confidence Interval (± stems/ ha)		4,960	423	280	944	3,001	555	92	1,486	30	121	60	82	164	121	896	0	30	576	8,336
2018 Expected Density (stems/ha)		5,000	450	0	200	1,417	250	33	233	17	183	33	67	350	817	567	33	17	467	10,133
2018 Confidence Interval (± stems/ ha)		4,798	251	0	159	2,351	183	60	312	30	136	60	68	226	524	380	40	30	281	7,377

Figure 1. Growth of black cottonwood and Douglas-fir at BDR-PRM01 on September 2, 2020.

Figure 2. Red alder and herbaceous cover at ULL-PRM01 on September 1, 2020.

Figure 3. Black cottonwood and red alder regeneration at ULL-PRM02 on September 1, 2020, along with herbaceous fireweed (*Epilobium angustifolium*) cover.

Figure 4. Rocky substrate and tree regeneration at ULL-PRM03 on September 1, 2020.

Figure 5. Black cottonwood regeneration at ULL-PRM08 on September 2, 2020.

Figure 6. Sparse herbaceous cover with abundant woody regeneration along stream edge at ULL-PRM09 on September 2, 2020.

Figure 7. Planted stock at ULL-PRM07, including western red cedar in the background, on September 2, 2020.

Figure 8. Abundant black cottonwood regeneration at ULL-PRM11 on September 2, 2020.

4.1.1.2. Percent Vegetation Cover

The average percent vegetation cover was 24% across all revegetation areas represented by monitoring plots in Year 3 (Table 12), which is an increase from the average of 7% cover in Year 1. Percent cover increased from Year 1 to Year 3 at every plot except for ULL-PRM09, which was the same plot where stem density decreased (see Section 4.1.1.1). Estimated percent vegetation cover varied by revegetation area, ranging from 8% in the areas represented by ULL-PRM09 and ULL-PRM03, to 55% in the areas represented by ULL-PRM01 (Table 12). Substantial exposed soil was noted in Year 1, as was expected for the first year of monitoring. Hydroseeding was not recommended at most sites as it can prevent the establishment of more desirable woody vegetation species, thus, high percent vegetation cover is not expected within the first five years of operational monitoring. There was still exposed soil present in all areas in Year 3, and soils appeared rocky and dry; however, the overall trend was of increasing cover. No areas of exposed geotextile were noted in the vicinity of ULL-PRM09 (which is adjacent to ULL-ASTR04) during riparian revegetation monitoring in Year 3 (Section 2.9.1). An earlier spot check of amphibian habitat was conducted on August 24, 2020, when a small portion of exposed geotextile was observed and covered (Section 4.5.1).

Vegetation cover (i.e., ground cover of low plants) is monitored because it stabilizes the soil and provides sediment interception and erosion control functions early in the revegetation process. However, taller woody vegetation also contributes to this function. Thus, although vegetation cover remained under the target of 80% in Year 3, shrub and tree stem density targets were met in all but one of the plots (i.e., shrub density in ULL-PRM03), and revegetation in general is progressing well. Vegetation cover may increase, at least in the short term, as existing vegetation fills the growing space and new plants are recruited. Conversely, as woody vegetation increases in height and density in some plots, vegetation cover may decline. No sedimentation or erosion issues were noted at the time of the assessment, although there is still potential for erosion given the amount of exposed soil present in Year 3.

4.1.1.3. Photopoint Comparison

Standard photographs, taken through plot centres facing north (0°), are presented in Appendix F. These photos were used to support the Year 3 assessment and were compared to photographs taken in Year 1 of monitoring. Additional repeatable representative photographs that show specific parts of the riparian revegetation areas are presented in Appendix G. Comparison of these photographs were used to aid in the evaluation of revegetation performance and the need for additional revegetation or monitoring work. All standard photographs taken from above the plot centre to the east (90º), south (180º), and west (270º), are available upon request.

Comparison of photographs taken in Year 3 generally support the results of the two quantitative assessment methods. In particular, the comparison demonstrates: 1) stem density is generally increasing, along with size of plants (which is not apparent from stem density counts); and 2) vegetation cover is increasing in the majority of plots. It is also apparent that there are still areas of exposed soil in most plots, although the overall trend of increasing stem density and herbaceous cover suggests that revegetation is progressing successfully.

4.2. Water Temperature and Air Temperature

4.2.1. Overview

The results of the baseline (2008-2013) and operational (2018-2020) water temperature metrics for the Upper Lillooet River and Boulder Creek are summarized in the following sections. Water temperature site photographs are presented in Appendix C; BC WQG for water temperature, annual water temperature figures, and data summary tables are presented in Appendix D; QA/QC spot temperature figures are presented in Appendix H.

The period of record at Upper Lillooet River and Boulder Creek monitoring sites for Years 1, 2, and 3 (2018, 2019, and 2020) is from March 2018 to October 2020 (Table 5, Table 6, Map 2, Map 3). Data availability are based on the most recent download of water temperature loggers and data gaps are documented in Section 3.2.1.

The BDR-USWQ baseline site may be influenced by groundwater during the fall and winter periods, therefore the upstream site in nearby North Creek (NTH-USWQ1), which has data overlapping the baseline period of record at BDR-USWQ, was re-established to augment the water temperature record (i.e., data influenced by localized groundwater inflow at BDR-USWQ can not be used as an effective baseline control record). Data from the upstream site located in North Creek was successfully retrieved for the period spanning October 2019 to October 2020 (Year 3). Tidbits, which had been installed at BDR-USWQ2 in September 2018 were deemed missing during the next site visit in October 2019. Tidbits were re-established at this site in October 2019 and data were successfully collected through to October 2020.

At the end of Year 2 of monitoring, the upstream site in the Upper Lillooet River, ULL-USWQ02 was decommissioned due to difficult access which requires a helicopter; data collection began at a new upstream site, ULL-USWQ03 in Year 2, and data collection continued at this site in Year 3.

The Upper Lillooet River and Boulder Creek baseline temperature records are provided in Appendix D. The Upper Lillooet River and Boulder Creek operational temperature regimes are presented using a) daily average temperature data, b) daily maximum temperature data and c) daily minimum temperature data (Figure 9 and Figure 10, respectively).

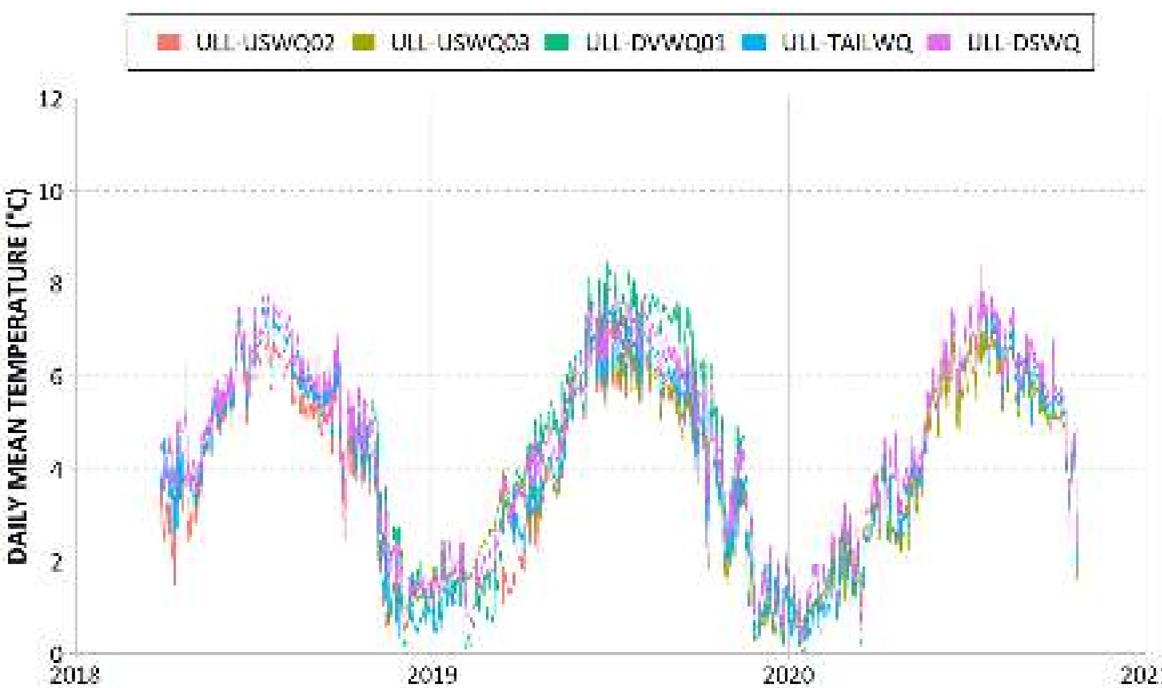
The pattern of inter-station differences in water temperature is displayed graphically in Section 7 of Appendix D for baseline conditions, and for operational conditions it is shown in Figure 11 (Upper Lillooet) and Figure 12 (Boulder Creek). The water temperature data will be assessed at the end of the LTMP period when all five years of operational data have been collected for a Project effect via a BACI analysis.

The water temperature at the Upper Lillooet River downstream site (ULL-DSWQ), diversion site (ULL-DVWQ01), and the tailrace site (ULL-TAILWQ) was warmer than the water temperature at the upstream site (ULL-USWQ03) for the majority of the data record (Figure 11). During baseline, there is a similar pattern to operations of water temperature at the diversion site (ULL-DVWQ) being warmer than at the upstream site (ULL-USWQ1) (Section 7, Appendix D), but the difference is small (<1°C for the majority of the time) both during baseline and operational periods. Temperature loggers at USWQ02 were removed on October 11, 2019, therefore ULL-USWQ03 data are presented for Year 3. Comparison between operational water temperatures between ULL-USWQ02 and ULL-USWQ03 show that temperatures are similar between the two stations (Figure 11).

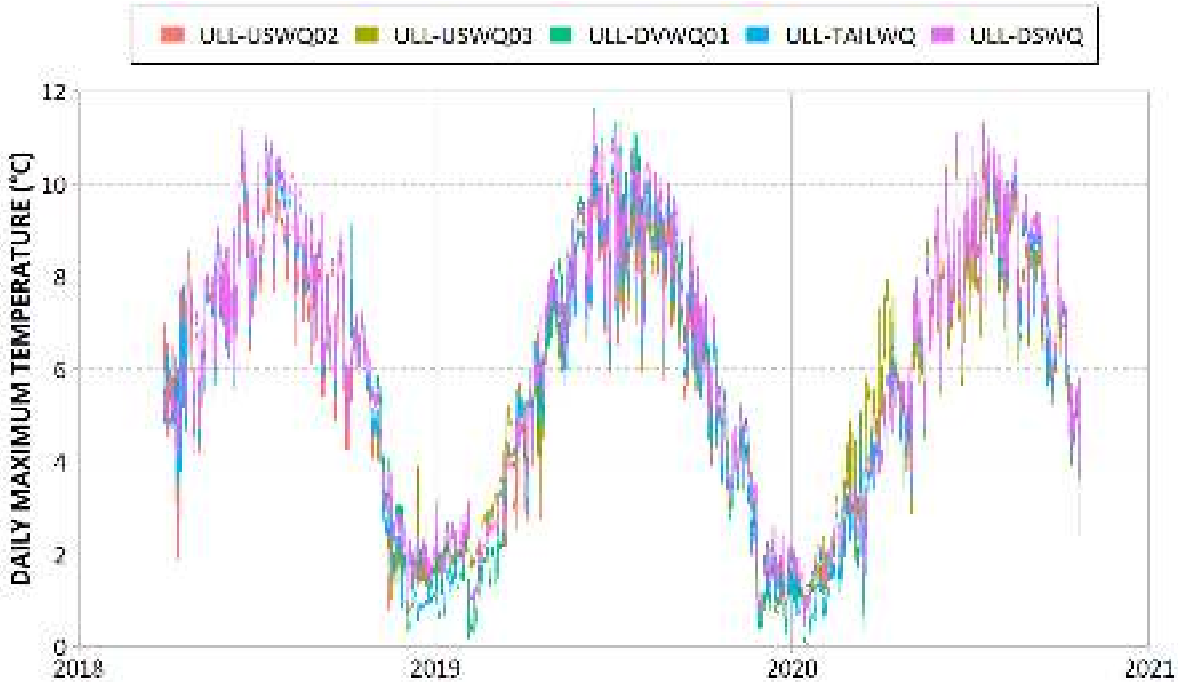
In Boulder Creek during operations, water temperature at the downstream site (BDR-DSWQ), diversion site (BDR-DVWQ), and the tailrace site (BDR-TAILWQ) was warmer than the water temperature at the upstream control site (BDR-USWQ2) for the vast majority of the data record (Figure 12). With respect to the operational data available at the end of Year 3, the pattern of inter-station differences in water temperature suggests that the temperature at site BDR-DVWQ (diversion reach) relative to the upstream control site the Boulder Creek upstream site is tracking warmer for more of the time than under baseline conditions (Section 7, Appendix D). Comparison between operational water temperatures between NTH-USWQ1 and BDR-USWQ2 indicated that temperatures are slightly warmer at NTH-USWQ1 than at BDR-USWQ2 for most of the period of record but the difference is <1°C for the majority of the dataset (Figure 12).

Figure 9. Daily mean, maximum, and minimum water temperature collected in the Upper Lillooet River during operations (2018 to 2020).

(a) Daily Average



(b) Daily Maximum



(c) Daily Minimum

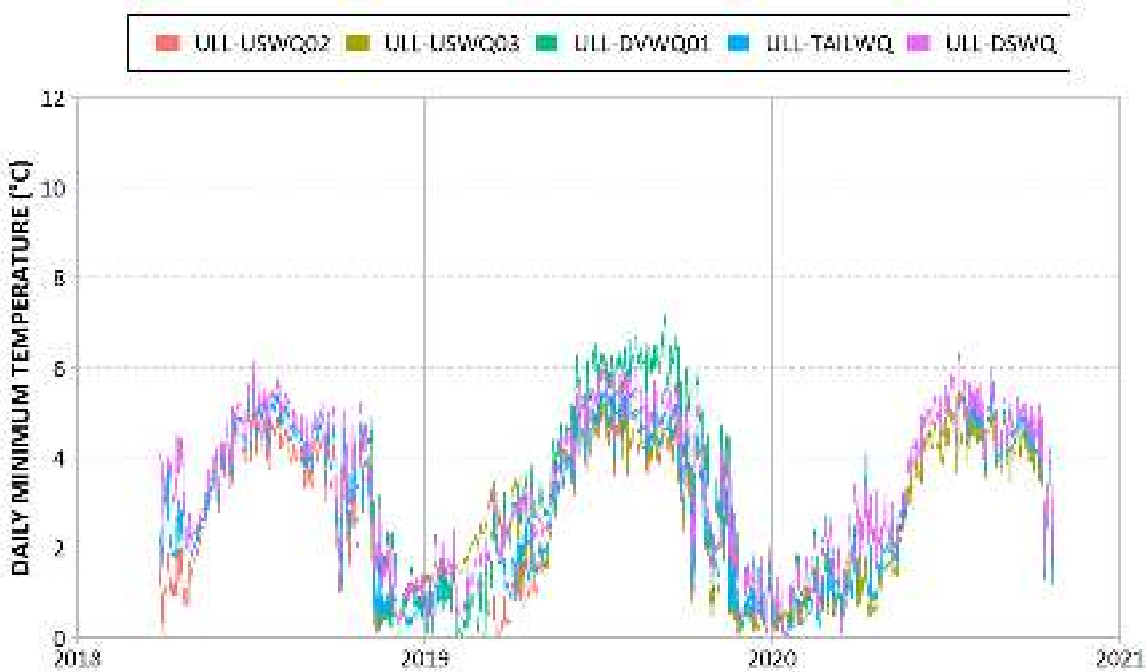
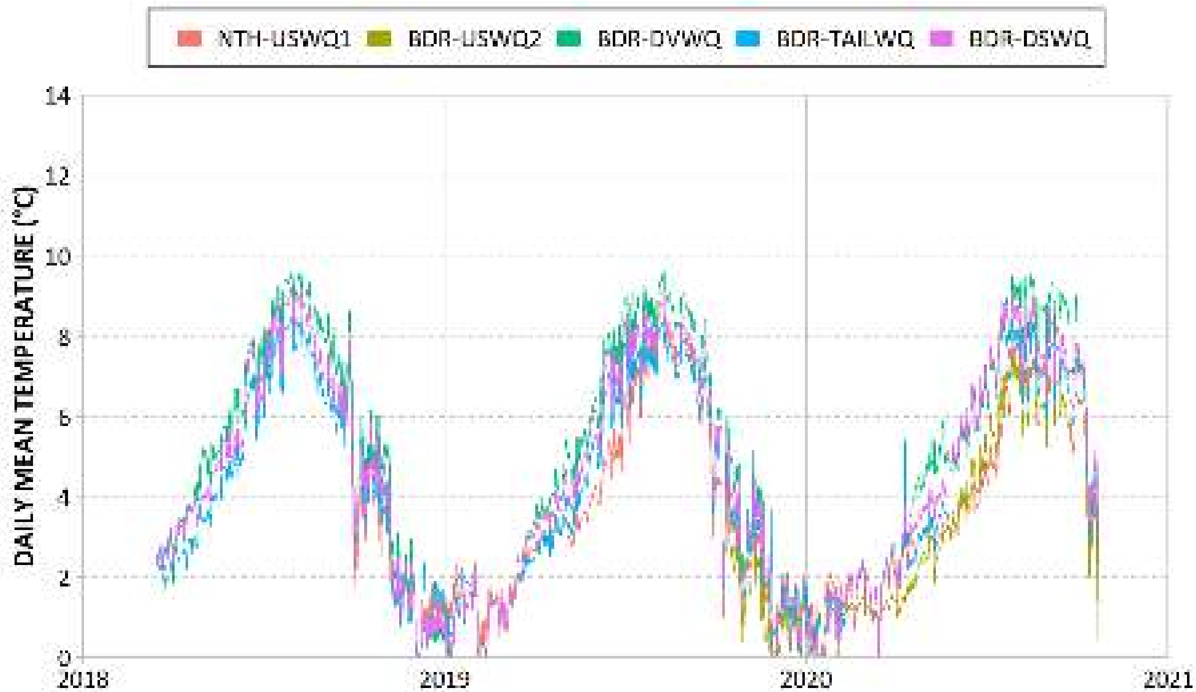
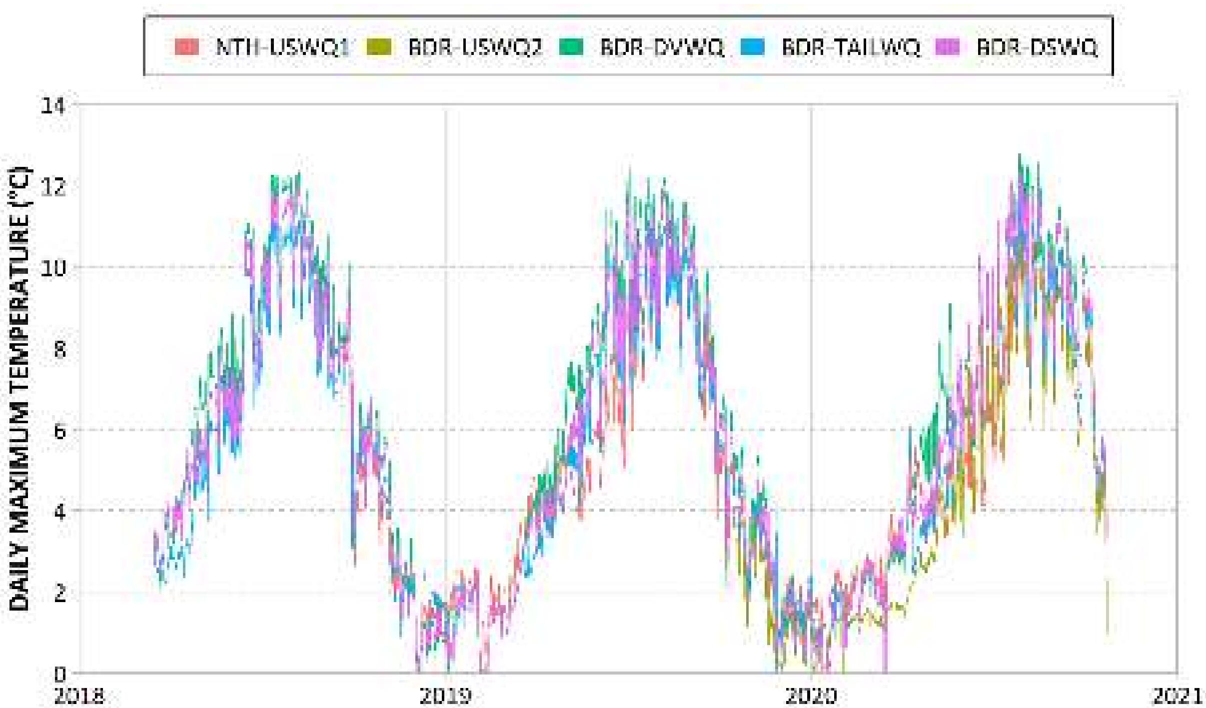


Figure 10. Daily mean, maximum and minimum water temperature collected in Boulder Creek during operations (2018 to 2020).

(a) Daily Average



(b) Daily Maximum



(c) Daily Minimum

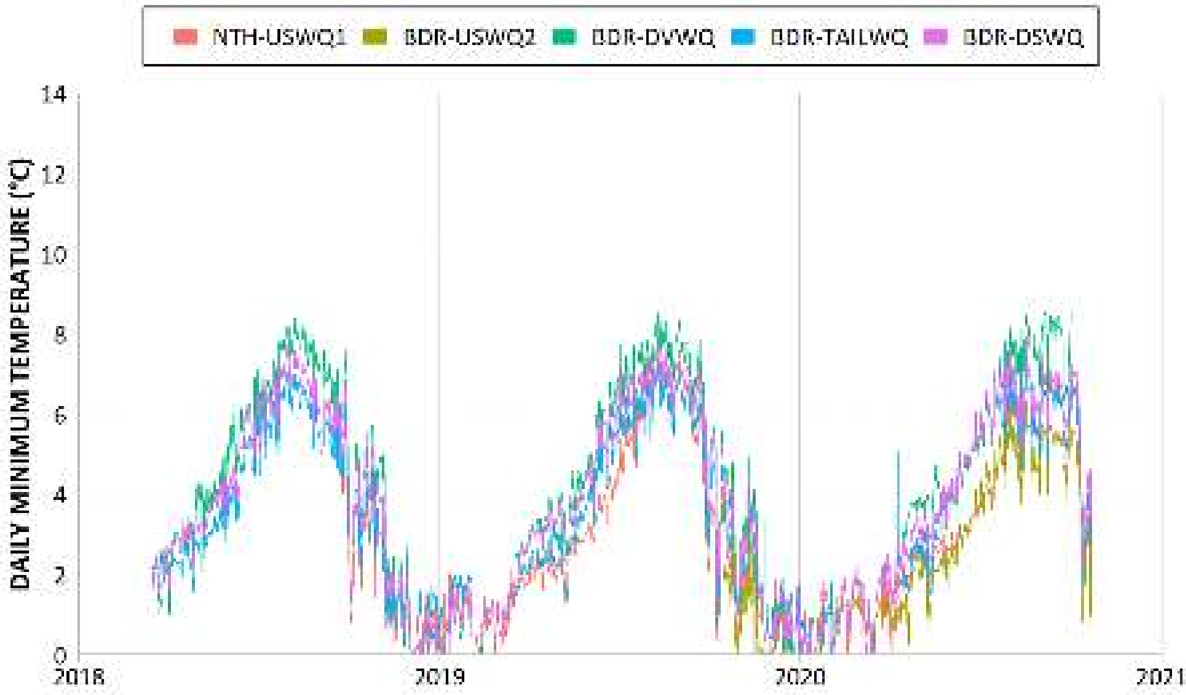


Figure 11. **Cumulative frequency distribution of instantaneous water temperature between the Upper Lillooet River monitoring sites and ULL-USWQ03 during operations (2018 to 2020).**

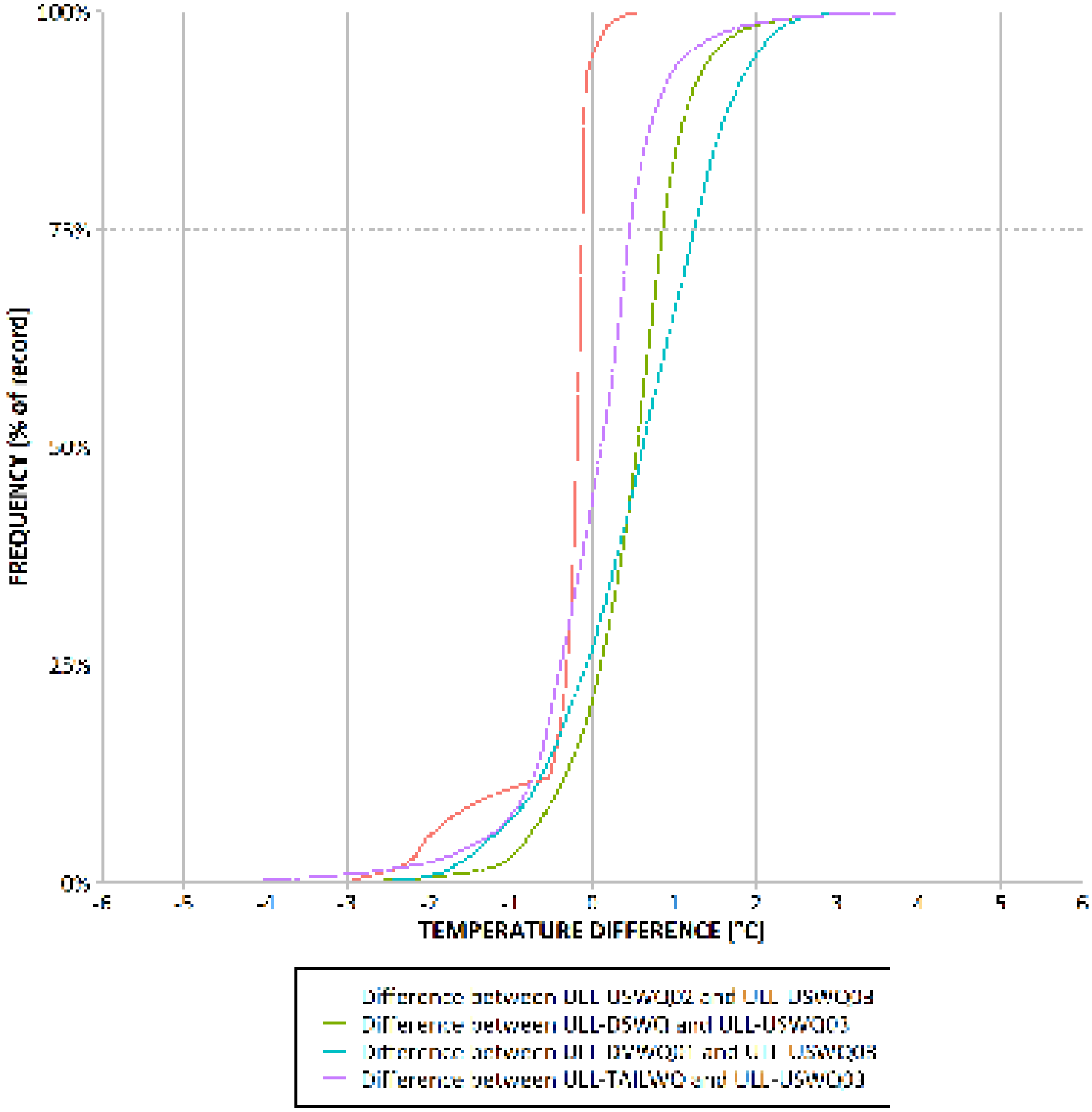
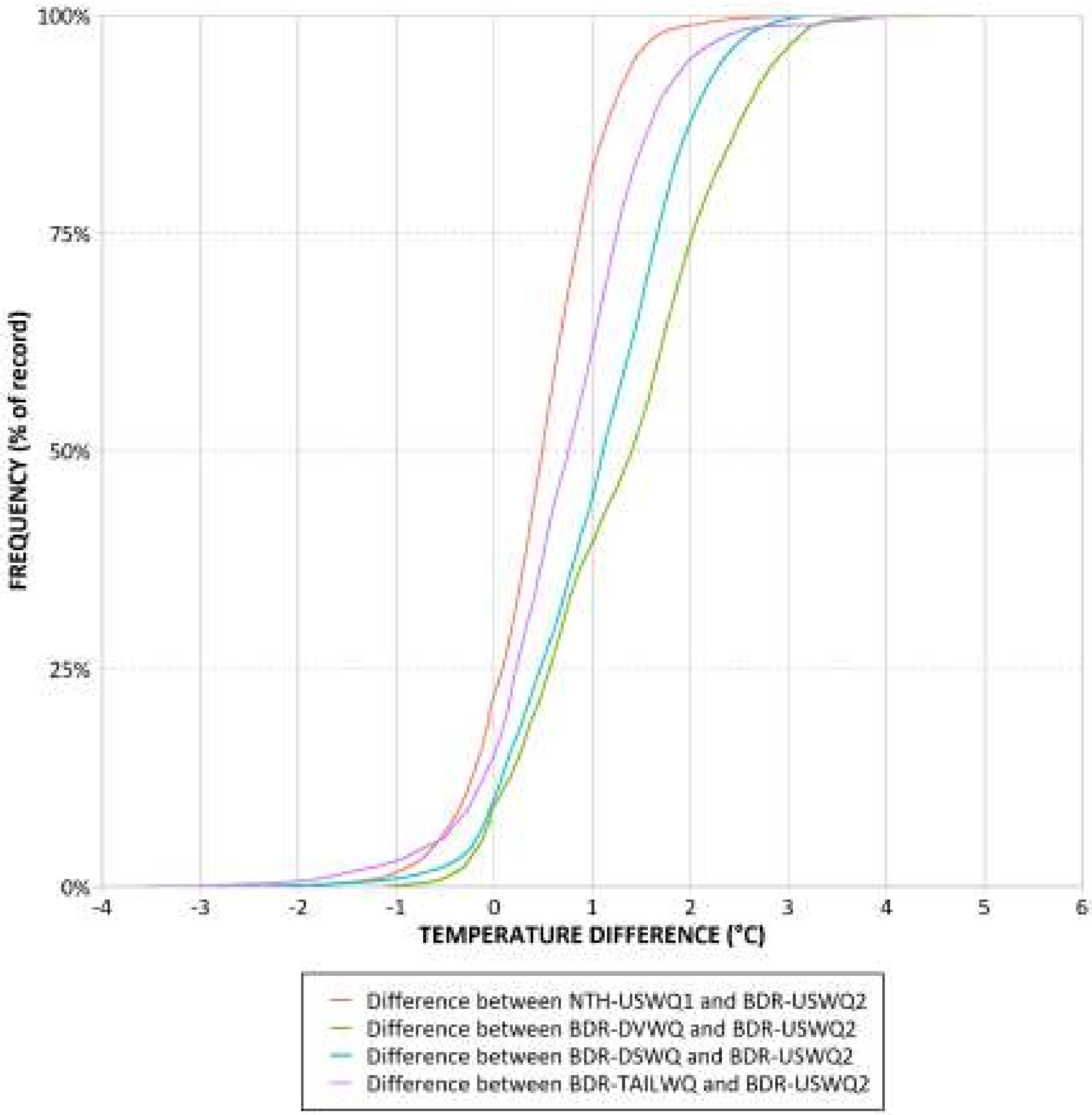


Figure 12. Cumulative frequency distribution of instantaneous water temperature between the Boulder Creek monitoring sites and BDR-USWQ2 during operations (2019-2020).



4.2.2. Monthly Summary Statistics

The Upper Lillooet River and Boulder Creek mean/average, instantaneous minimum, instantaneous maximum, and standard deviation for water temperature for each month of the record are summarized for the baseline period (upstream and diversion) in Appendix D and operational period (upstream, diversion, tailrace and downstream) in Section 4.2.2.1.

The Upper Lillooet River and Boulder Creek mean/average, instantaneous minimum, instantaneous maximum, and standard deviation for air temperature for each month of the record are summarized for the baseline period (upstream and diversion) in Appendix D and operational period (upstream, diversion, tailrace and downstream) in Section 4.2.2.2.

4.2.2.1. Water Temperature

The range in monthly average water temperature in the upstream reach of Upper Lillooet River was 0.4°C to 7.3°C during baseline monitoring (Section 4 of Appendix D), and was 0.8°C to 7.6°C during operational monitoring to date (Table 14). The warmest average monthly water temperature to date in the Upper Lillooet River was at lower diversion site during operations in July 2019 (7.6°C, Table 14) and the coolest average monthly water temperature to date in the Upper Lillooet River occurred during baseline at the upstream site ULL-USWQ1 in December 2009 (0.4°C) (Section 4 of Appendix D).

The range in monthly average water temperature in the diversion reach of Boulder Creek was 0.5°C to 7.9°C during baseline monitoring and was 0.6°C to 8.8°C during operational monitoring to date (Table 15, Section 4 of Appendix D). The coldest average monthly water temperature in the Boulder Creek diversion reach during operations occurred in December 2018 and January 2020 (0.6°C) and the warmest month occurred during operations in August 2018 and 2019 (8.8°C). At the Boulder Creek downstream site (BDR-DSWQ) the range in monthly average water temperature was 0.7°C to 8.2°C. The coldest average monthly water temperature occurred in December 2018 and January 2020, and the warmest average monthly water temperature in July 2018 and August 2019 (Table 15).

Table 14. Upper Lillooet River operational monthly water temperature summary statistics (2018 to 2020).

Year	Month	Water Temperature[1] (°C)																			
		ULL-USWQ02				ULL-USWQ03				ULL-DVWQ01				ULL-TAILWQ				ULL-DSWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2018	Apr	3.0	0.0	8.6	1.8	-	-	-	-	-	-	-	-	3.7	1.8	7.8	1.3	4.3	1.9	8.0	1.1
	May	4.3	1.4	8.8	1.8	-	-	-	-	-	-	-	-	4.5	1.8	8.8	1.7	4.8	2.1	9.1	1.7
	Jun	5.9	3.3	11.0	1.5	-	-	-	-	-	-	-	-	6.1	3.5	11.2	1.5	6.3	3.7	11.3	1.5
	Jul	6.4	3.7	10.3	1.6	-	-	-	-	-	-	-	-	6.9	4.1	10.9	1.7	7.2	4.4	11.1	1.7
	Aug	5.7	3.3	9.1	1.4	-	-	-	-	-	-	-	-	6.2	3.8	9.9	1.5	6.5	4.0	10.2	1.5
	Sep	5.2	2.2	8.8	1.2	-	-	-	-	-	-	-	-	5.6	2.8	9.3	1.2	5.8	3.1	9.4	1.1
	Oct	4.0	1.0	7.2	1.3	-	-	-	-	-	-	-	-	4.6	1.0	9.2	1.0	4.8	1.7	7.2	1.0
	Nov	-	-	-	-	1.8	0.2	5.1	1.2	3.0	0.8	5.9	1.2	2.0	0.2	5.1	1.2	2.7	0.8	5.5	1.0
	Dec	-	-	-	-	1.1	0.3	3.9	0.4	1.2	0.1	2.6	0.6	0.8	0.2	2.2	0.3	1.3	0.4	2.9	0.4
2019	Jan	-	-	-	-	1.6	1.2	2.5	0.2	1.6	0.1	2.7	0.6	1.1	0.3	1.9	0.3	1.8	0.3	3.2	0.4
	Feb	-	-	-	-	2.0	1.4	3.0	0.3	0.9	0.1	2.3	0.7	-	-	-	-	1.5	0.4	3.2	0.6
	Mar	-	-	-	-	3.3	2.2	5.7	0.7	2.5	0.1	5.1	1.2	-	-	-	-	2.9	1.2	5.2	0.8
	Apr	2.9	0.4	8.2	1.7	3.7	1.1	7.7	1.4	4.3	2.0	7.4	1.2	3.3	0.8	8.0	1.6	4.0	2.0	8.1	1.3
	May	4.6	1.4	9.1	1.9	4.7	1.4	9.5	2.0	5.6	2.7	9.7	1.8	4.7	1.6	9.0	1.8	5.2	2.1	9.5	1.8
	Jun	6.1	3.1	10.9	1.7	6.3	3.3	11.2	1.7	7.2	4.2	11.7	1.6	6.3	3.3	11.1	1.7	6.8	3.7	11.5	1.7
	Jul	6.2	3.6	10.2	1.4	6.4	3.7	10.4	1.5	7.6	4.9	11.4	1.5	6.7	3.9	10.7	1.5	7.2	4.4	11.2	1.5
	Aug	5.9	3.6	9.3	1.4	6.0	3.7	9.6	1.4	7.4	4.7	10.2	1.2	6.4	4.0	10.0	1.4	6.9	4.5	10.5	1.5
	Sep	5.2	2.4	8.8	1.1	5.3	2.6	9.0	1.1	6.8	4.0	9.6	1.0	5.5	2.8	9.3	1.1	6.0	3.4	9.7	1.1
	Oct	-	-	-	-	3.8	0.5	7.4	1.4	4.8	1.4	7.1	1.4	4.0	1.0	7.2	1.3	4.3	1.4	7.6	1.4
	Nov	-	-	-	-	2.1	0.1	4.8	1.2	3.1	0.2	5.3	1.3	2.3	0.3	4.8	1.2	2.9	0.4	5.2	1.2
	Dec	-	-	-	-	0.8	0.1	2.3	0.4	1.2	0.1	2.5	0.6	1.0	0.3	2.3	0.4	1.4	0.1	2.6	0.5
2020	Jan	-	-	-	-	0.9	0.1	1.8	0.3	1.0	0.0	2.1	0.6	-	-	-	-	1.2	0.1	2.2	0.6
	Feb	-	-	-	-	1.6	0.4	4.9	0.7	1.8	0.6	3.3	0.7	1.3	0.2	3.3	0.7	2.0	0.4	3.7	0.7
	Mar	-	-	-	-	2.3	0.4	7.3	1.3	-	-	-	-	2.2	0.5	5.1	0.9	2.6	0.1	5.1	1.0
	Apr	-	-	-	-	2.9	0.3	7.9	1.7	-	-	-	-	-	-	-	-	3.8	1.4	6.1	1.0
	May	-	-	-	-	4.2	1.4	9.5	1.9	-	-	-	-	-	-	-	-	4.7	1.9	9.5	1.7
	Jun	-	-	-	-	5.8	3.4	10.9	1.5	-	-	-	-	-	-	-	-	6.3	3.9	11.1	1.5
	Jul	-	-	-	-	6.4	3.6	10.6	1.5	-	-	-	-	-	-	-	-	7.1	4.4	11.3	1.6
	Aug	-	-	-	-	6.0	3.6	9.9	1.5	-	-	-	-	6.3	3.7	10.2	1.5	6.6	3.9	10.6	1.5
	Sep	-	-	-	-	5.5	3.4	8.9	1.2	-	-	-	-	5.7	4.0	9.2	1.1	6.1	4.3	9.4	1.2
	Oct	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

[1] Statistics based on continuous data logged at 15 minute intervals. Statistics were not generated for months with less than three weeks of data.
Minimum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in red.

Table 15. Boulder Creek operational monthly water temperature statistics (2018 to 2020).

Year	Month	Water Temperature[1] (°C)																			
		BDR-USWQ2				NTH-USWQ1				BDR-DVWQ				BDR-DSWQ				BDR-TAILWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2018	Apr	-	-	-	-	-	-	-	-	3.5	1.0	6.5	0.9	3.4	1.6	6.0	0.6	2.8	1.6	5.5	0.5
	May	-	-	-	-	-	-	-	-	5.2	2.1	8.5	1.2	4.7	2.9	8.1	1.1	4.1	2.5	7.3	1.1
	Jun	-	-	-	-	-	-	-	-	6.9	4.6	11.1	1.3	6.3	3.9	10.8	1.4	5.8	3.4	10.9	1.4
	Jul	-	-	-	-	-	-	-	-	8.6	5.5	12.3	1.6	8.2	4.9	11.9	1.6	7.6	4.5	11.2	1.6
	Aug	-	-	-	-	-	-	-	-	8.8	6.7	12.3	1.2	8.1	5.7	12.0	1.3	7.6	5.1	11.2	1.3
	Sep	-	-	-	-	-	-	-	-	7.5	4.5	10.8	0.9	6.7	3.6	10.2	1.0	6.3	3.1	9.6	1.0
	Oct	-	-	-	-	3.7	0.8	6.3	1.1	4.9	1.3	6.8	1.1	4.5	1.4	6.7	0.9	4.3	2.2	6.5	0.9
	Nov	-	-	-	-	2.1	0.2	4.5	0.9	2.8	0.2	5.8	1.3	2.4	0.5	5.4	1.1	2.0	0.3	4.8	1.1
	Dec	-	-	-	-	1.0	0.0	2.1	0.6	0.6	0.0	2.0	0.5	0.7	0.0	2.0	0.5	-	-	-	-
2019	Jan	-	-	-	-	1.6	0.0	2.6	0.6	1.1	0.0	2.4	0.7	1.2	0.0	2.5	0.6	1.5	0.4	2.2	0.6
	Feb	-	-	-	-	1.0	0.0	2.6	0.6	0.8	0.0	2.2	0.6	0.8	0.0	2.2	0.6	-	-	-	-
	Mar	-	-	-	-	2.0	0.1	4.8	0.9	2.0	0.5	4.3	0.8	2.0	0.5	3.8	0.8	-	-	-	-
	Apr	-	-	-	-	3.0	1.6	5.9	0.8	3.8	2.6	6.0	0.7	3.5	2.7	4.7	0.4	3.0	2.1	4.8	0.5
	May	-	-	-	-	3.4	1.3	6.0	0.9	5.2	2.5	9.0	1.3	4.6	2.3	8.6	1.2	4.0	1.4	7.9	1.2
	Jun	-	-	-	-	4.8	2.8	7.9	1.1	7.2	4.2	11.4	1.5	6.7	3.7	10.8	1.5	6.2	3.2	10.2	1.5
	Jul	-	-	-	-	6.9	4.6	10.8	1.3	8.5	5.8	12.4	1.4	7.9	5.4	11.8	1.3	7.3	4.9	11.1	1.3
	Aug	-	-	-	-	7.9	5.4	11.9	1.3	8.8	6.3	12.2	1.2	8.2	5.9	11.8	1.2	7.6	5.4	11.0	1.2
	Sep	-	-	-	-	6.4	2.1	11.2	1.5	7.5	3.5	11.3	1.4	7.0	3.6	10.7	1.3	6.5	2.7	10.2	1.3
	Oct	-	-	-	-	3.1	0.3	5.7	1.3	4.4	1.0	6.8	1.5	4.0	1.1	6.5	1.4	3.7	0.7	6.4	1.2
	Nov	1.5	0.0	3.9	1.1	2.1	0.0	4.3	1.2	2.8	0.0	5.3	1.5	2.6	0.0	4.8	1.2	-	-	-	-
	Dec	0.6	0.1	1.5	0.4	1.2	0.0	2.5	0.6	1.0	0.0	2.4	0.7	1.0	0.1	2.2	0.5	1.2	0.4	2.1	0.5
2020	Jan	0.6	0.1	1.4	0.4	1.1	0.0	2.6	0.8	0.6	0.0	1.9	0.6	0.7	0.0	1.9	0.6	0.9	0.4	2.4	0.4
	Feb	1.1	0.1	1.6	0.4	1.6	0.0	2.9	0.6	1.5	0.0	2.6	0.6	1.5	0.1	2.8	0.6	-	-	-	-
	Mar	1.2	0.2	1.7	0.3	1.7	0.0	3.9	0.9	1.8	0.0	3.6	0.8	1.8	0.0	3.8	0.8	-	-	-	-
	Apr	1.8	0.3	3.0	0.6	2.6	0.0	5.6	1.0	3.5	1.1	6.1	1.0	3.1	1.1	5.2	0.7	-	-	-	-
	May	2.9	0.6	5.9	0.9	3.2	1.2	5.7	0.7	5.0	2.9	9.1	1.1	4.3	2.3	7.9	1.0	-	-	-	-
	Jun	4.3	2.2	8.6	1.3	4.0	2.6	7.0	0.9	5.9	3.7	10.1	1.3	6.0	3.9	10.3	1.3	-	-	-	-
	Jul	6.2	3.4	11.1	1.6	5.9	3.6	10.7	1.6	8.0	5.0	12.8	1.7	7.9	5.1	12.3	1.6	-	-	-	-
	Aug	6.5	3.8	10.6	1.5	7.3	4.6	11.4	1.4	8.7	6.3	12.6	1.3	7.8	5.1	12.0	1.4	7.3	4.7	11.4	1.4
	Sep	6.2	3.9	9.5	1.2	7.3	3.8	11.2	1.4	8.5	6.3	11.5	1.0	7.5	5.4	11.1	1.2	7.1	4.9	10.4	1.1

[1] Statistics based on continuous data logged at 15 minute intervals. Statistics were not generated for months with less than three weeks of data.

Minimum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the operational monitoring period are shaded in red.

4.2.2.2. Air Temperature

The range in monthly average air temperature in the upstream reach of Upper Lillooet River was -7.8°C to 15.3°C during baseline monitoring (Section 5 of Appendix D) and was -5.8°C to 15.9°C during operational monitoring to date (Table 16). The warmest month occurred in July 2018 and the coolest in January 2013 (a data gap occurred in winter 2019 and 2020).

In the Upper Lillooet River diversion and downstream reach, monthly average air temperature ranged from -4.4°C to 16.7°C during baseline monitoring (Section 5 of Appendix D), and from -8.2°C to 18.5°C during operational monitoring to date (Table 16). The warmest month occurred in July 2018 and the coolest in February 2019.

Air temperature was collected at the same location along the lower diversion reach of Boulder Creek in baseline and operational monitoring. The range in monthly average air temperature in the diversion reach of Boulder Creek was -4.2°C to 16.5°C during baseline monitoring (Section 5 of Appendix D), and -7.2°C to 18.8°C during operational monitoring to date (Table 17). At BDR-DVWQ, the coldest average monthly air temperatures occurred in February 2019 (-7.2°C) and the warmest average monthly air temperatures occurred in July 2018 (18.8°C).

The air temperature observations are in accordance with the water temperature trends observed in the Upper Lillooet River and Boulder Creek (see Section 4.2.1 and Section 4.2.2.1). Since air temperature is one of the primary drivers of water temperature, the air temperature data suggest that the water temperature trends observed during operations are likely largely reflective of natural inter annual variation in climate conditions. Project related effects will be evaluated using a BACI analysis following five years of data collection.

Table 16. Upper Lillooet River operational (2018 to 2020) air temperature monthly data summary statistics. Data from ULL-USAT02 were not included because only two months of data were available (November and December 2019).

Year	Month	Air Temperature[1] (°C)							
		ULL-USAT01				ULL-DSAT			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2018	Mar	-	-	-	-	-	-	-	-
	Apr	3.8	-6.5	20.0	4.8	4.5	-3.2	20.2	4.0
	May	9.8	-1.7	27.2	7.2	13.0	2.1	27.9	5.7
	Jun	12.0	0.2	32.1	6.3	13.4	3.9	33.1	5.6
	Jul	15.9	3.7	32.7	7.1	18.5	7.1	34.3	6.2
	Aug	14.7	3.0	31.6	6.8	17.5	7.6	33.7	5.5
	Sep	9.2	-0.1	27.0	4.9	10.5	2.9	26.3	3.7
	Oct	4.3	-4.3	19.5	4.9	5.5	-1.6	13.4	2.9
	Nov	-0.6	-8.8	11.5	3.7	1.1	-3.3	10.5	2.7
	Dec	-5.8	-18.5	1.6	5.7	-3.0	-11.1	1.5	3.2
2019	Jan	-	-	-	-	-2.8	-10.0	1.3	2.7
	Feb	-	-	-	-	-8.2	-19.7	2.5	5.2
	Mar	-	-	-	-	-0.9	-14.7	9.0	4.6
	Apr	-	-	-	-	3.4	-1.7	12.7	2.9
	May	-	-	-	-	12.3	1.2	29.3	6.1
	Nov	-	-	-	-	1.1	-10.5	8.4	3.8
	Dec	-	-	-	-	-2.2	-10.2	2.1	2.8
2020	Jan	-	-	-	-	-3.9	-21.3	2.4	6.1
	Feb	-	-	-	-	-1.8	-9.9	4.5	2.8
	Mar	-	-	-	-	-0.8	-13.4	8.7	3.6
	Apr	-	-	-	-	3.0	-6.3	12.4	3.2
	May	-	-	-	-	10.2	0.0	26.5	5.3
	Jun	-	-	-	-	12.9	4.2	26.3	4.4
	Jul	-	-	-	-	16.3	6.5	32.4	5.4
	Aug	-	-	-	-	15.6	6.4	31.1	5.0
	Sep	-	-	-	-	13.6	5.3	26.3	4.2

[1] Statistics based on data logged at 30-minute intervals and were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

Table 17. Boulder Creek operational (2018 to 2020) air temperature data summary statistics.

Year	Month	Air Temperature[1] (°C)			
		BDR-DVAT			
		Avg	Min	Max	SD
2018	Mar	-	-	-	-
	Apr	5.6	-3.1	25.5	4.7
	May	13.7	3.5	28.8	6.1
	Jun	13.6	4.3	34.2	5.8
	Jul	18.8	8.1	36.5	7.1
	Aug	18.3	8.4	35.9	6.1
	Sep	11.1	3.0	28.9	4.1
	Oct	6.0	-1.8	15.2	2.8
	Nov	1.6	-3.0	12.3	2.6
	Dec	-2.5	-10.0	3.8	2.9
2019	Jan	-2.0	-9.3	2.9	2.4
	Feb	-7.2	-18.9	4.0	5.1
	Mar	0.0	-14.3	9.9	4.5
	Apr	5.3	-0.8	17.2	3.8
	May	13.8	2.6	30.0	6.4
	Jun	15.6	4.2	31.5	5.7
	Jul	16.2	7.2	29.9	5.0
	Aug	17.1	8.4	32.2	5.4
	Sep	12.3	2.1	30.2	4.3
	Oct	4.8	-2.5	14.5	3.0
	Nov	1.5	-10.4	8.4	3.9
	Dec	-1.9	-9.2	2.8	2.5
2020	Jan	-3.6	-19.9	3.0	6.1
	Feb	-1.1	-8.8	5.9	2.8
	Mar	-0.1	-13.1	11.2	3.7
	Apr	5.1	-5.8	18.3	4.4
	May	11.8	1.3	27.5	5.4
	Jun	12.5	4.9	26.9	4.9
	Jul	16.4	6.6	35.6	6.1
	Aug	16.5	7.1	34.6	5.6
	Sep	14.3	5.6	30.4	4.8
	Oct	-	-	-	-

[1] Statistics based on data logged at 30-minute intervals and were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

4.2.3. Growing Season Degree Days

In both the Upper Lillooet River (Table 18) and Boulder Creek (Table 19) monitoring sites, the upstream sites generally have shorter growing seasons than the diversion and downstream sites, as would be expected due to cooler water temperatures at higher elevations.

The start of the growing season based on the water temperature record is variable in the Upper Lillooet River (Table 18). During baseline monitoring, the growing season start dates at the upstream and diversion sites varied from late-May to early-July. During operations, the start date occurred in mid- to late-May in all years (2018 to 2020) (Table 18). The growing season end dates occurred in October during baseline and operational years for most sites, except in the downstream reach (ULL-DSWQ) and tailrace (ULL-TAILWQ) during operations in 2018, when the growing season ended in early November. A notable exception to the end of the growing season was at ULL-USWQ02 in 2018 when the growing season ended on September 30 coincident with cold air temperatures; the cooling was not enough to end the growing season at the tailrace and downstream sites where the growing season continued until early November. The length of the growing season in the Upper Lillooet River during baseline monitoring ranged from 644-degree days to 861-degree days at the upstream site and was 825 degree days at the diversion site. During operations, the growing season ranged from 746 to 839 degree days at the upstream sites, from 922 to 1,121 degree days at the diversion and downstream sites, and from 854 to 963 days in the tailrace (Table 18). The longest growing season occurred in the diversion during operations (ULL-DVWQ01) in 2019.

In Boulder Creek during the baseline period, the growing season start dates and end dates were variable (Table 19). During baseline, start dates occurred between late-May and mid-August (North Creek), with end dates occurring from early October to early November. The operational growing season start date occurred from mid-May to late June and ended from late-September (North Creek) to late-October (Boulder Creek). The length of the growing season in Boulder Creek during baseline ranged from 367-degree days upstream to 898-degree days in the diversion. During operations, the length of the growing season in Boulder Creek ranged from 644-degree days (upstream site) to 1,185 degree days, with the longest growing season recorded in 2019 in the diversion reach at BDR-DVWQ (Table 19).

Table 18. Upper Lillooet River growing season length and degree days during baseline and operations.

Project Phase	Site	Year	No. of days with valid data	Growing Season				
				Start Date	End Date	Length (day)	Gap (day)	Degree Days
Baseline	ULL-USWQ1	2008	41	-	-	-	-	-
		2009	365	22-May-09	8-Oct-09	141	0	861
		2010	365	28-Jun-10	13-Oct-10	109	0	644
		2011	365	2-Jul-11	23-Oct-11	114	0	693
		2012	364	20-Jun-12	17-Oct-12	119	2	707
		2013	153	23-May-13	-	-	-	-
	ULL-DVWQ	2010	49	-	-	-	-	-
		2011	97	-	-	-	-	-
		2012	366	6-Jun-12	18-Oct-12	135	0	825
		2013	120	-	-	-	-	-
Operation	ULL-USWQ02	2018	230	23-May-18	30-Sep-18	132	0	746
		2019	211	20-May-19	6-Oct-19	141	0	798
	ULL-USWQ03	2018	60	-	-	-	-	-
		2019	364	18-May-19	7-Oct-19	143	0	839
		2020	295	24-May-20	11-Oct-20	142	0	817
	ULL-DVWQ01	2018	60	-	-	-	-	-
		2019	365	13-May-19	25-Oct-19	167	0	1,121
		2020	75	-	-	-	-	-
	ULL-TAILWQ	2018	259	21-May-18	3-Nov-18	167	6	963
		2019	293	20-May-19	7-Oct-19	142	0	854
		2020	188	-	12-Oct-20	-	-	-
	ULL-DSWQ	2018	278	19-May-18	4-Nov-18	171	0	1,020
		2019	365	16-May-19	23-Oct-19	161	0	1,016
		2020	295	21-May-20	13-Oct-20	147	0	922

"-" denote periods where insufficient data were available to accurately assess the entire length of the growing season.

Degree days are accumulated thermal units.

Table 19. Boulder Creek growing season length and degree days during baseline and operations.

Project Phase	Site	Year	No. of days with valid data	Growing Season				
				Start Date	End Date	Length (day)	Gap (day)	Degree Days
Baseline	BDR-USWQ	2010	235	6-Jul-10	2-Nov-10	119	11	634
		2011	364	2-Aug-11	12-Oct-11	71	0	367
		2012	365	23-Jul-12	16-Oct-12	86	1	479
		2013	118	-	-	-	-	-
	NTH-USWQ1	2010	111	-	17-Oct-10	-	-	-
		2011	365	18-Aug-11	10-Oct-11	55	0	280
		2012	366	26-Jul-12	16-Oct-12	83	0	474
		2013	121	-	-	-	-	-
	BDR-DVWQ	2008	45	-	-	-	-	-
		2009	365	31-May-09	8-Oct-09	131	0	898
		2010	351	13-Jun-10	29-Oct-10	139	11	895
		2011	354	7-Jul-11	14-Oct-11	100	2	617
		2012	366	3-Jul-12	19-Oct-12	109	0	726
		2013	156	23-May-13	-	-	-	-
Operation	BDR-USWQ2	2019	81	-	-	-	-	-
		2020	295	30-Jun-20	11-Oct-20	104	0	644
	NTH-USWQ1	2018	98	-	25-Oct-18	-	-	-
		2019	283	17-Jun-19	30-Sep-19	106	0	721
		2020	295	11-Jul-20	12-Oct-20	93	0	651
	BDR-DVWQ	2018	290	17-May-18	3-Oct-18	140	0	1,062
		2019	296	15-May-19	24-Oct-19	164	0	1,185
		2020[1]	274	2-Jun-20	-	-	-	-
	BDR-TAILWQ	2018	255	9-Jun-18	29-Oct-18	143	8	919
		2019	235	29-May-19	7-Oct-19	132	2	887
		2020	161	-	-	-	-	-
	BDR-DSWQ	2018	290	20-May-18	2-Oct-18	136	0	959
		2019	296	23-May-19	8-Oct-19	138	0	997
		2020[1]	295	30-May-20	-	-	-	-

[1]Results will be reported once remaining 2020 data are available

"-" denote periods where insufficient data were available to accurately assess the entire length of the growing season.

Degree days are accumulated thermal units.

4.2.4. Hourly Rates of Water Temperature Change

Rapid changes in temperature (greater than ±1.0°C/hr) can affect fish growth and survival (Oliver and Fidler 2001). Hourly rates of change in water temperature were compared to the BC WQG, which specify that the hourly rate of water temperature change should not exceed ±1.0°C/hr (MOE 2019). Based on Ecofish's experience collecting baseline temperature data on several other streams in British Columbia (file data), it is normal for a small percentage of data points to have hourly rates of water temperature change that exceed ±1.0°C/hr.

During baseline, the percentage (%) of record where exceedances were observed was low (≤0.51%) in the Upper Lillooet River and Boulder Creek monitoring sites (Table 20, Table 21, and Section 8 of Appendix D). Exceedances occurred more often during operations, particularly at the upstream site ULL-USWQ02 in the Upper Lillooet River (Table 20) and at the tailrace and downstream sites for Boulder Creek, however, exceedances as a percentage of the record were still relatively low (≤1.29%, Table 21).

Table 20. Upper Lillooet River hourly water temperature rate of change (°C/hr) summary statistics and occurrence of rate of change in exceedance of ± 1.0°C/hr.

Project Phase	Site	Period of Record		Number of Datapoints	Occurrence		Min -ve	Percentile				Max +ve
		Start	End		No.	% of Record		1st	5th	95th	99th	
Baseline	ULL-USWQ1	19-Nov-08	03-Jun-13	158,955	803	0.51	-1.344	-0.734	-0.5	0.642	0.921	1.97
	ULL-DVWQ	12-Nov-10	01-May-13	60,846	25	0.04	-1.02	-0.668	-0.41	0.51	0.792	1.12
Operation	ULL-USWQ02	28-Mar-18	11-Oct-19	42,503	661	1.56	-1.42	-0.88	-0.65	0.80	1.03	2.42
	ULL-USWQ03	01-Nov-18	22-Oct-20	69,218	476	0.69	-2.73	-0.80	-0.54	0.67	0.93	2.07
	ULL-DVWQ01	01-Nov-18	16-Mar-20	48,097	93	0.19	-1.30	-0.67	-0.36	0.44	0.80	1.53
	ULL-TAILWQ	28-Mar-18	22-Oct-20	73,859	601	0.82	-4.56	-0.82	-0.57	0.71	0.93	5.05
	ULL-DSWQ	28-Mar-18	22-Oct-20	90,140	398	0.44	-2.44	-0.78	-0.53	0.65	0.88	2.78

Table 21. Boulder Creek hourly water temperature rate of change (°C/hr) summary statistics and occurrence of rate of change in exceedance of ± 1.0°C/hr.

Project Phase	Site	Period of Record		Number of Datapoints	Occurrence		Min-ve	Percentile				Max+ve
		Start	End		No.	% of Record		1st	5th	95th	99th	
Baseline	BDR-USWQ	22-Apr-10	01-May-13	26,274	157	0.15	-1.91	-0.543	-0.314	0.395	0.791	1.22
	NTH-USWQ1	12-Sep-10	01-May-13	92,298	10	0.01	-1.56	-0.43	-0.26	0.33	0.67	1.11
	BDR-DVWQ	15-Nov-08	06-Jun-13	39,576	471	0.30	-1.37	-0.499	-0.30	0.36	0.82	1.58
Operation	BDR-USWQ2	11-Oct-19	22-Oct-20	36,187	316	0.87	-2.71	-0.64	-0.37	0.44	0.96	2.12
	NTH-USWQ1	24-Sep-18	22-Oct-20	72,857	367	0.50	-1.53	-0.57	-0.35	0.47	0.88	1.38
	BDR-DVWQ	16-Mar-18	01-Oct-20	89,285	732	0.82	-3.21	-0.59	-0.37	0.48	0.95	1.78
	BDR-TAILWQ	16-Mar-18	22-Oct-20	70,734	907	1.29	-5.79	-0.61	-0.40	0.54	1.05	4.13
	BDR-DSWQ	16-Mar-18	22-Oct-20	91,296	993	1.09	-2.96	-0.58	-0.38	0.46	1.02	2.10

Figure 13. Upper Lillooet River summary of the hourly rate of change (°C/hr) during operations.

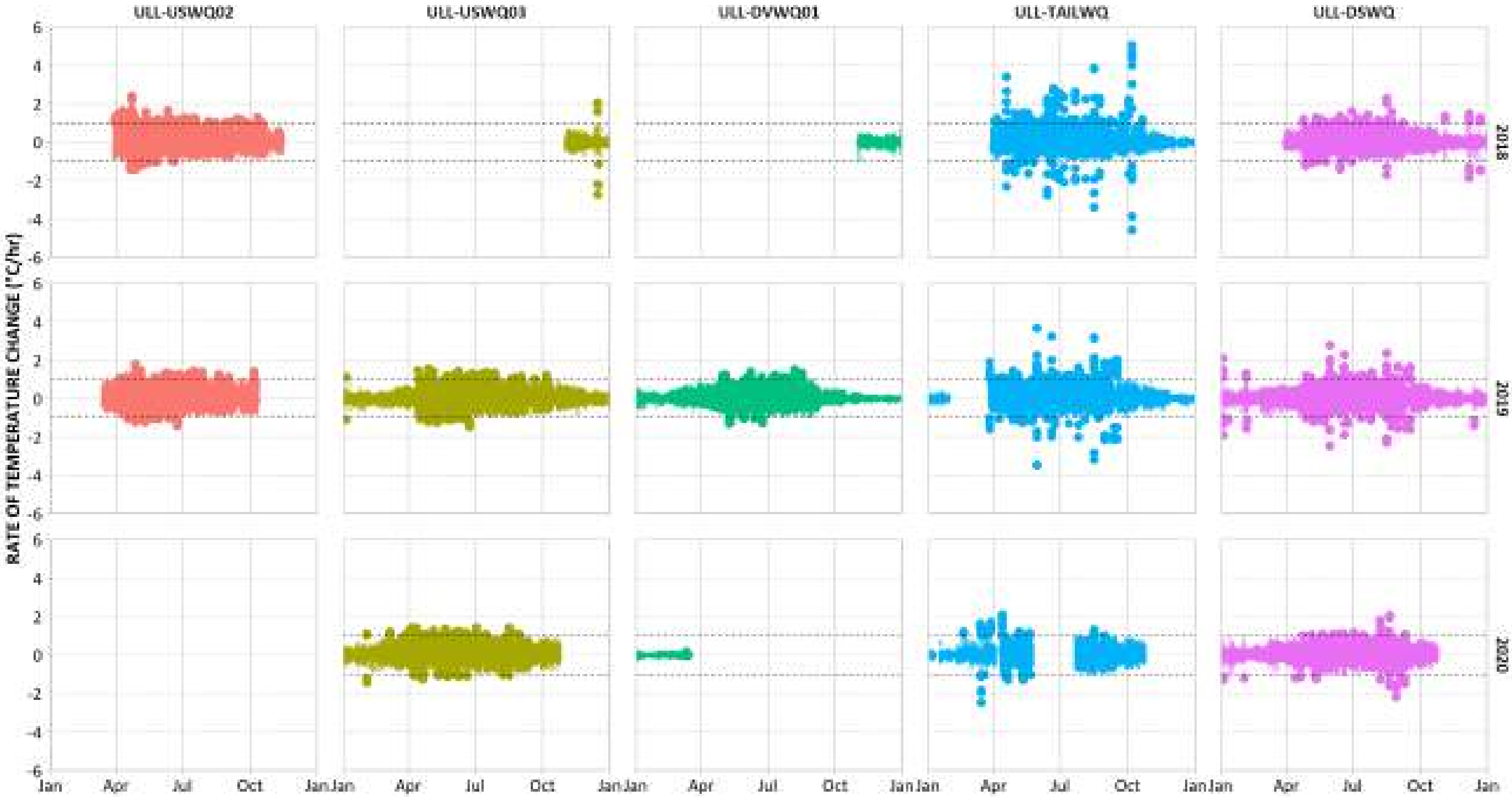
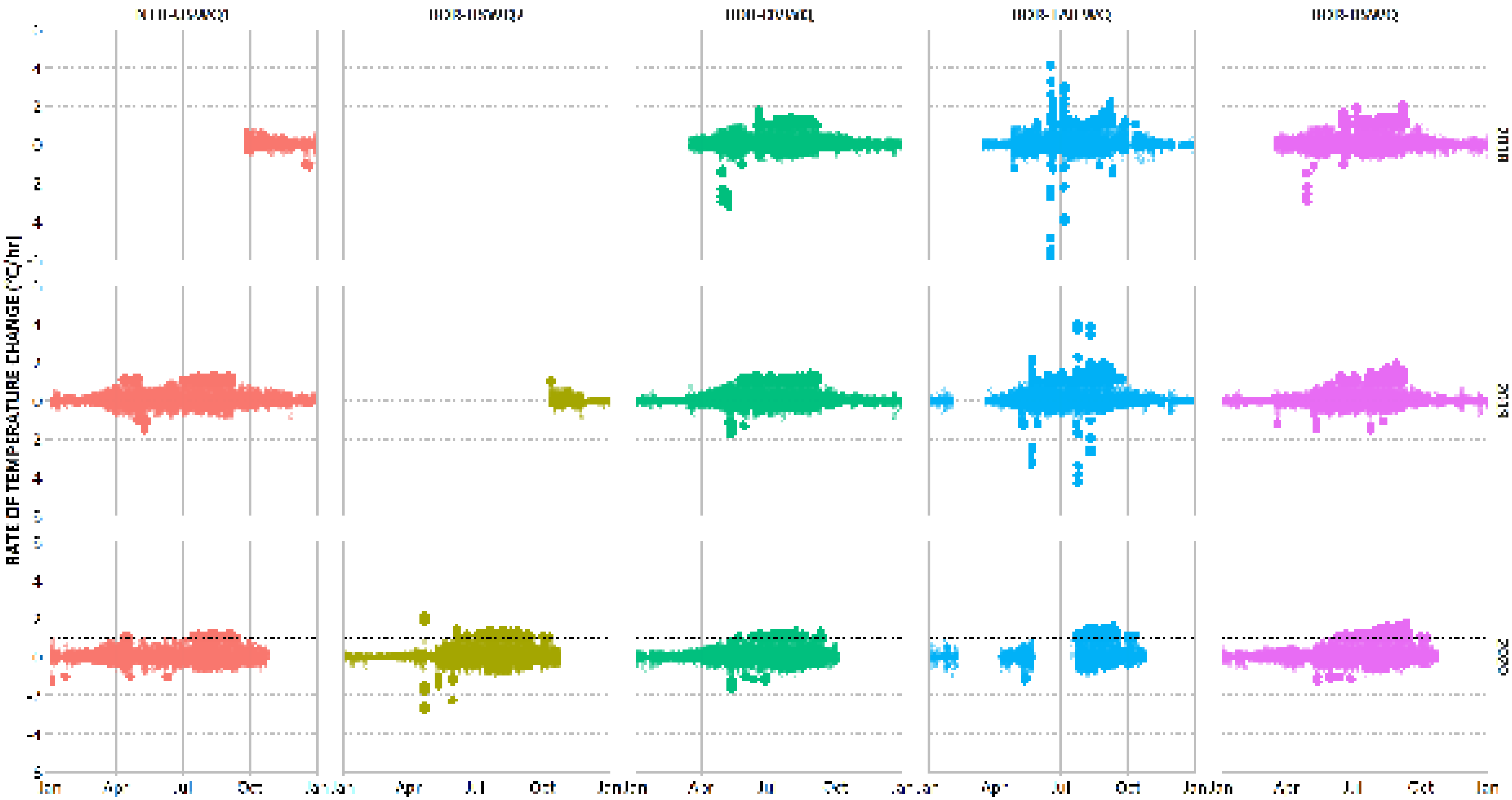


Figure 14. Boulder Creek summary of hourly rate of change (°C/hr) for each year during operations.



4.2.5. Daily Temperature Extremes

Upper Lillooet River and Boulder Creek are classified as cool streams based on the lack of days with average water temperatures >18°C (Table 22 and Table 23). Considering all sites and dates in Upper Lillooet River, the maximum instantaneous water temperature during baseline monitoring was 11.8°C at the upstream site in July 2009[1]; during operations it was 11.7°C at the diversion site in June 2019 (Table 14). Considering all sites and dates in Boulder Creek, the maximum instantaneous water temperature during baseline monitoring was 11.4°C at the diversion site in July 2009, and 12.8°C at the diversion site in July 2020 (Table 15).

The number of days in a calendar year with daily average temperatures <1°C in Upper Lillooet River during baseline ranged from 32 to 95, and during operations, ranged from 12 to 36 (Table 22).

The number of days with daily average temperatures <1°C in Boulder Creek during baseline ranged from 33 to 83, and during operations, ranged from 19 to 49 (Table 23).

[1] The lower diversion site in July 2009 was likely warmer than the maximum instantaneous water temperature observed at the upstream site, however there is no data for the lower diversion site during this period as temperature sensors did not survive the 2009 freshet.

Table 22. Upper Lillooet River summary of daily average water temperature extremes (number of days >18°C and <1°C).

Project Phase	Site	Year	n (days)	Days T_{water} > 18°C	Days T_{water} > 20°C	Days T_{water} < 1°C
Baseline	ULL-USWQ1	2008	41	-	0	-
		2009	365	0	0	95
		2010	365	0	0	58
		2011	365	0	0	86
		2012	365	0	0	74
		2013	153	-	-	33
	ULL-DVWQ	2010	49	-	-	-
		2011	97	-	-	-
		2012	366	0	0	32
		2013	120	-	-	-
Operation	ULL-USWQ02	2018	230	0	0	-
		2019	211	0	0	-
		2020	0	-	-	-
	ULL-USWQ03	2018	60	-	-	-
		2019	364	0	0	28
		2020	295	0	0	23
	ULL-DVWQ01	2018	60	-	-	-
		2019	365	0	0	36
		2020	75	-	-	-
	ULL-DSWQ	2018	278	0	0	-
		2019	365	0	0	21
		2020	295	0	0	12
	ULL-TAILWQ	2018	259	0	0	-
		2019	293	0	0	-
		2020	188	0	0	-

n is the number of days that have observations for at least 23 hours.

"-" denotes periods when insufficient data were available

Table 23. Boulder Creek summary of daily average water temperature extremes (number of days >18°C and <1°C).

Project Phase	Site	Year	n (days)	Days T_{water} > 18°C	Days T_{water} > 20°C	Days T_{water} < 1°C
Baseline	BDR-USWQ	2010	235	0	0	-
		2011	364	0	0	42
		2012	365	0	0	47
		2013	118	-	-	-
	NTH-USWQ1	2010	98	-	-	-
		2011	365	0	0	43
		2012	366	0	0	48
		2013	121	-	-	-
	BDR-DVWQ	2008	45	-	-	-
		2009	365	0	0	66
		2010	351	0	0	33
		2011	354	0	0	83
		2012	366	0	0	58
		2013	156	-	-	-
Operation	BDR-USWQ2	2019	81	-	-	-
		2020	295	0	0	40
	NTH-USWQ1	2018	98	-	-	-
		2019	365	0	0	36
		2020	295	0	0	21
	BDR-DVWQ	2018	290	0	0	-
		2019	365	0	0	49
		2020	274	0	0	-
	BDR-TAILWQ	2018	255	0	0	-
		2019	287	0	0	19
		2020	161	0	0	-
	BDR-DSWQ	2018	290	0	0	-
		2019	365	0	0	48
		2020	295	0	0	-

n is the number of days that have observations for at least 23 hours.

† Operational water temperature Tidbit monitoring commenced on March 16, 2018

4.2.6. Bull Trout Temperature Guidelines

Bull Trout specific water temperate guidelines (Table 8) were applied to the water temperature records by calculating the number of days of exceedance of the minimum and maximum temperature thresholds (Table 24 and Table 25). For both Upper Lillooet and Boulder Creek, the upstream sites were not considered as Bull Trout are not present in the upstream reaches (Table 7). In BC, Bull Trout are considered to have the highest thermal sensitivity of the native salmonids evaluated in Oliver and Fiddler (2001), therefore more restrictive guidelines are applied to streams with this species.

During baseline and operational monitoring periods, the highest maximum daily temperatures did not exceed the prescribed thresholds for rearing (15°C) in Upper Lillooet River or Boulder Creek (Table 24 and Table 25).

The number of days where daily maximum water temperatures were outside the Bull Trout thresholds for spawning and incubation (i.e., >10°C) in a calendar year during baseline monitoring are only available for 2012 in the diversion reach of the Upper Lillooet River (six days, Table 24). During operations, considering the diversion, tailrace, and downstream sites, this number varied from zero to nine (Table 24). In Boulder Creek, the number of days in a calendar year where daily maximum water temperatures were outside the thresholds for spawning and incubation (i.e., >10°C) ranged from two to 16 during in the baseline record at the diversion site, and from 14 to 32 during operations considering data from the diversion, tailrace, and downstream sites (Table 25).

The number of days where the minimum temperature was less than the incubation threshold (i.e., <2°C) were relatively high in both streams (Table 24 and Table 25) due to cooler temperatures during the winter months (Table 14 and Table 15). Overall, the number of exceedances of the lower temperature threshold of 2°C were similar during operations to date (2018-2020), in comparison to the baseline record.

Table 24. Upper Lillooet River summary of the number of days where the daily minimum or maximum water temperature (°C) exceeds the Bull Trout BC WQG thresholds (MOE 2019).

Project Phase	Site	Year	n (days)[1]	Rearing (Year Round)	Spawning (Aug.1 - Dec. 8)	Incubation (Aug. 1 - Mar. 1)	
				T_{water} > 15°C	T_{water} > 10°C	T_{water} < 2°C	T_{water} > 10°C
Baseline	ULL-DVWQ	2010	49	-	-	-	-
		2011	97	-	-	-	-
		2012	366	0	6	110	6
		2013	120	-	-	-	-
Operation	ULL-DVWQ01	2018	60	-	-	102	-
		2019	365	0	5	92	5
		2020	75	-	-	-	-
	ULL-TAILWQ	2018	259	0	0	-	0
		2019	293	-	0	90	0
		2020	188	0	3	-	3
	ULL-DSWQ	2018	278	0	4	105	4
		2019	365	0	9	101	9
		2020	295	0	7	-	7

[1] n is the number of days that have observations for at least 23 hours within the calendar year.

T_{water} is the total number of days where the minimum or maximum water temperature is outside the BC WQG threshold.

A dash (-) denotes values that are not reported due data gaps exceeding a threshold of 14 consecutive or 28 cumulative days during spawning or incubation periods, or less than 50% of the year for rearing.

Incubation spans two calendar years; the results are reported in the calendar year when the period started (i.e. August 2018 to March 2019 is reported in 2018).

Table 25. Boulder Creek summary of the number of days where the daily minimum or maximum water temperature (°C) exceeds the Bull Trout BC WQG thresholds (MOE 2019).

Project Phase	Site	Year	n (days)[1]	Rearing (Year Round)	Spawning (Aug.1 - Dec. 8)	Incubation (Aug. 1 - Mar. 1)	
				T_{water} > 15°C	T_{water} > 10°C	T_{water} < 2°C	T_{water} > 10°C
Baseline	BDR-DVWQ	2008	45	-	-	-	-
		2009	365	0	7	124	11
		2010	351	0	12	92	16
		2011	354	0	2	125	2
		2012	366	0	12	112	16
		2013	156	-	-	-	-
Operation	BDR-DVWQ	2018	290	0	23	48	30
		2019	365	0	32	108	32
		2020	274	0	-	-	-
	BDR-TAILWQ	2018	255	0	12	-	-
		2019	287	0	14	62	14
		2020	161	0	-	-	-
	BDR-DSWQ	2018	290	0	15	52	21
		2019	365	0	25	110	25
		2020	295	0	-	-	-

[1] n is the number of days that have observations for at least 23 hours within the calendar year.

T_{water} is the total number of days where the minimum or maximum water temperature is outside the BC WQG threshold.

A dash (-) denotes values that are not reported due data gaps exceeding a threshold of 14 consecutive or 28 cumulative days during spawning or incubation periods, or less than 50% of the year for rearing.

Incubation spans two calendar years; the results are reported in the calendar year when the period started (i.e. August 2018 to March 2019 is reported in 2018).

4.2.7. Mean Weekly Maximum Temperature (MWMxT)

MWMxT is an important indicator of prolonged periods of warm water temperatures that fish are exposed to. The guideline for the protection of aquatic life states "Where fish distribution information is available, then mean weekly maximum water temperatures should only vary + or – 1°C beyond the optimum temperature range of each life history phase (migration, incubation, rearing, and spawning) for the most sensitive salmonid species present" (MOE 2019).

A comparison of MWMxT temperature data to optimum temperature ranges for Coho Salmon, Cutthroat Trout, and Bull Trout was completed for each species based on their distribution (Table 7) in the upstream (Table 26), diversion (Table 27, Table 28, Table 29) and downstream (Table 30) reaches of the Upper Lillooet River, and the diversion (Table 33 and Table 34) and downstream (Table 35) reaches of Boulder Creek. The upstream reach of Boulder Creek is non fish bearing.

Each of the MWMxT tables provides the percent complete of the data record for each life stage along with the minimum and maximum MWMxT range in each period. The percentage of data within each optimum temperature range is provided to evaluate the overall suitability of the temperate range for each fish species life stage. Exceedance of the BC WQG (MOE 2019) range (greater than ±1°C outside the optimum ranges) are highlighted in each summary table where blue indicates MWMxTs are cooler than the lower guidelines by more than 1°C and red indicates temperatures are higher than the upper guidelines by more than 1°C. MWMxT results were not calculated for the tailrace sites.

The year-round range in MWMxT temperature corresponds to the rearing life stage for all the fish species. During baseline monitoring, MWMxT ranged from 0.1°C to 10.8°C in Upper Lillooet River and from 0.0°C to 11.0°C in Boulder Creek. During operational monitoring to date (2018-2020), MWMxT ranged from 0.4°C to 10.7°C in the Upper Lillooet River and from 0.0°C to 12.1°C in Boulder Creek.

MWMxT values in relation to species-specific optimal temperature ranges differed by species and location. In general, with the exception of Bull Trout, MWMxTs are within or below (cooler than) the optimal temperature ranges. Bull Trout prefer cooler temperatures overall in comparison to Cutthroat Trout and Coho Salmon, therefore fewer exceedances of the cooler temperature limits are observed for this species. Exceedances of the upper limit of the optimum temperatures for Bull Trout spawning and incubation were observed during baseline and operational monitoring in Upper Lillooet River and Boulder Creek (see red shading in Table 29, Table 32, Table 34, and Table 36).

Table 26. Upper Lillooet River upstream baseline (2008-2013) and operational (2018-2020) MWMxTs measured during Cutthroat Trout life history stages.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2008	0.0	-	-	-	-	-
			92	2009	100	4.7	9.5	64.1	17.4	0.0
			92	2010	100	4.1	8.1	96.7	0.0	0.0
			92	2011	100	3.8	7.0	100	0.0	0.0
			92	2012	100	3.1	7.6	100	0.0	0.0
			92	2013	69.6	4.4	7.8	100	0.0	0.0
			92	2018	97.8	4.6	9.9	84.4	6.7	0.0
			92	2019	100	4.7	10.1	57.6	19.6	0.0
			92	2020	100	4.3	9.1	77.2	1.1	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2008	0.0	-	-	-	-	-
			124	2009	100	6.5	10.8	26.6	46.0	0.0
			124	2010	100	5.7	9.9	52.4	25.0	0.0
			124	2011	100	3.8	10.1	67.7	17.7	0.0
			124	2012	99	4.0	10.0	57.7	22.8	0.0
			124	2013	27.4	-	-	-	-	-
			124	2018	100	5.4	9.9	46.8	19.4	0.0
			124	2019	100	6.3	10.1	21.8	21.0	0.0
			124	2020	100	4.3	9.5	41.9	18.5	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	366	2008	9.8	-	-	-	-	-
			365	2009	100	0.1	10.8	52.3	40.3	0.0
			365	2010	100	0.3	9.9	57.0	30.4	0.0
			365	2011	100	0.4	10.1	61.4	24.1	0.0
			366	2012	99.5	0.1	10.0	58.2	26.9	0.0
			365	2013	42.2	-	-	-	-	-
			365	2018	74.8	0.9	9.9	36.3	48.0	0.0
			365	2019	99.7	0.7	10.1	54.7	35.2	0.0
			366	2020	80.9	0.9	9.5	43.6	42.6	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Grey shading indicates the percent complete is less than 50%, comparisons to the provincial guidelines are not included for <50% of data.

2008 - 2013 data were collected at ULL-USWQ1; Data in 2018 prior to November 1, 2018 were collected at ULL-USWQ02 while more recent data are from ULL-USWQ03.

Table 27. MWMxTs measured during Coho Salmon life history stages in the Upper Lillooet River diversion reach (ULL-DVWQ01) during baseline (2012) and operational (2018-2020) monitoring.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Coho Salmon	Migration (Sep. 01 to Dec. 31)	7.2-15.6	122	2012	100	1.1	9.5	63.1	25.4	0.0
			122	2018	45	-	-	-	-	-
			122	2019	100	0.8	9.1	68.9	21.3	0.0
			122	2020	0.0	-	-	-	-	-
	Spawning (Oct. 15 to Jan. 01)	4.4-12.8	79	2012	100	1.1	6.3	65.8	22.8	0.0
			79	2018	71	0.7	5.5	82.1	7.1	0.0
			79	2019	100	0.8	6.2	53.2	30.4	0.0
			79	2020	0.0	-	-	-	-	-
	Incubation (Oct. 15 to Apr. 01)	4.0-13.0	170	2012	100	0.5	6.3	66.3	18.9	0.0
			169	2018	86.4	0.4	5.5	79.5	12.3	0.0
			169	2019	90.6	0.2	6.2	68.8	19.5	0.0
			170	2020	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	9.0-16.0	366	2012	100	0.4	10.1	74.6	12.6	0.0
			365	2018	15.1	-	-	-	-	-
			365	2019	100	0.4	10.7	68.8	23.8	0.0
			366	2020	20.8	-	-	-	-	-

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.
2012 data were collected at ULL-DVWQ; 2018 and 2019 data were collected at ULL-DVWQ01.

Table 28. MWMxTs measured during Cutthroat Trout life history stages in the Upper Lillooet River diversion reach (ULL-DVWQ01) during baseline (2012) and operational (2018-2020) monitoring.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2012	100	3.6	8.5	90.2	0.0	0.0
			92	2018	0.0	-	-	-	-	-
			92	2019	100	4.7	10.7	55.4	28.3	0.0
			92	2020	0.0	-	-	-	-	-
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2012	100	4.5	10.1	46.0	31.5	0.0
			124	2018	0	-	-	-	-	-
			124	2019	100	7.0	10.7	16.9	67.7	0.0
			124	2020	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	366	2012	100	0.4	10.1	54.9	35.8	0.0
			365	2018	15.1	-	-	-	-	-
			365	2019	100	0.4	10.7	52.6	41.1	0.0
			366	2020	20.8	-	-	-	-	-

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.
2012 data were collected at ULL-DVWQ; 2018 and 2019 data were collected at ULL-DVWQ01.

Table 29. MWMxTs measured during Bull Trout life history stages in the Upper Lillooet River diversion reach (ULL-DVWQ01) during baseline (2012) and operational (2018-2020) monitoring.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Bull Trout	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2012	100	1.6	10.1	23.1	42.3	0.8
			130	2018	25	-	-	-	-	-
			130	2019	100	0.8	9.9	19.2	43.1	0.0
			130	2020	0.0	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	214	2012	100	0.5	10.1	5.6	34.3	30.0
			213	2018	54.0	0.4	5.5	11.3	36.5	0.0
			213	2019	100	0.2	9.9	6.5	30.8	27.6
			214	2020	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	366	2012	100	0.4	10.1	46.7	45.1	0.0
			365	2018	15.1	-	-	-	-	-
			365	2019	100	0.4	10.7	44.9	47.4	0.0
			366	2020	20.8	-	-	-	-	-

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.
2012 data were collected at ULL-DVWQ; 2018 and 2019 data were collected at ULL-DVWQ01.

Table 30. Operational (2018-2020) MWMxTs measured during Coho Salmon life history stages in the Upper Lillooet River downstream reach (ULL-DSWQ).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Coho Salmon	Migration (Sep. 01 to Dec. 31)	7.2-15.6	122	2018	100	1.6	8.5	59.8	21.3	0.0
			122	2019	100	1.1	9.2	68.9	17.2	0.0
			122	2020	42.6	-	-	-	-	-
	Spawning (Oct. 15 to Jan. 01)	4.4-12.8	79	2018	100	1.6	6.7	63.3	32.9	0.0
			79	2019	100	1.1	6.2	48.1	26.6	0.0
			79	2020	10.1	-	-	-	-	-
	Incubation (Oct. 15 to Apr. 01)	4.0-13.0	169	2018	100	1.1	6.7	66.9	24.3	0.0
			169	2019	100	1.0	6.2	62.4	21.2	0.0
			170	2020	4.7	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	9.0-16.0	365	2018	74.8	1.6	10.7	67.0	19.8	0.0
			365	2019	100	1.1	10.5	69.0	19.7	0.0
			366	2020	80.9	1.0	10.3	65.9	18.2	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 31. Operational (2018-2020) MWMxTs measured during Cutthroat Trout history stages in the Upper Lillooet River downstream reach (ULL-DSWQ).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2018	97.8	4.8	10.4	77.8	8.9	0.0
			92	2019	100	4.6	10.5	56.5	23.9	0.0
			92	2020	100	4.2	9.4	72.8	5.4	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2018	100	6.0	10.7	33.9	43.5	0.0
			124	2019	100	7.0	10.5	17.7	57.3	0.0
			124	2020	100	5.1	10.3	30.6	37.9	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2018	74.8	1.6	10.7	33.7	52.4	0.0
			365	2019	100	1.1	10.5	51.0	41.1	0.0
			366	2020	80.9	1.0	10.3	46.3	47.6	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 32. Operational (2018-2020) MWMxTs measured during Bull Trout life history stages in the Upper Lillooet River downstream reach (ULL-DSWQ).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Bull Trout	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2018	100	1.6	10.1	21.5	58.5	1.5
			130	2019	100	1.1	10.2	17.7	47.7	2.3
			130	2020	63.8	4.9	10.1	0.0	68.7	2.4
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2018	100	1.1	10.1	0.0	39.9	28.2
			213	2019	100	1.0	10.2	0.0	32.7	26.2
			214	2020	39.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2018	74.8	1.6	10.7	22.0	66.3	0.0
			365	2019	100	1.1	10.5	45.8	49.0	0.0
			366	2020	80.9	1.0	10.3	33.8	53.7	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 33. Baseline (2008 to 2013) and Operational (2018-2020) MWMxTs measured during Cutthroat Trout life history stages in the Boulder Creek diversion reach (BDR-DVWQ).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Between Bounds	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2008	0.0	-	-	-	-	-
			92	2009	100	2.5	10.3	76.1	4.3	0.0
			92	2010	97.8	3.2	7.8	100	0.0	0.0
			92	2011	92.4	2.8	5.7	100	0.0	0.0
			92	2012	100	2.6	6.1	100	0.0	0.0
			92	2013	68.5	3.4	7.8	100	0.0	0.0
			92	2018	100	3.2	10.6	79.3	12.0	0.0
			92	2019	100	4.2	10.8	60.9	23.9	0.0
			92	2020	100	3.0	8.6	92.4	0.0	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2008	0	-	-	-	-	-
			124	2009	100	4.5	11.0	32.3	45.2	0.0
			124	2010	99	5.1	10.8	50.4	42.3	0.0
			124	2011	93	3.6	9.4	72.2	7.8	0.0
			124	2012	100	4.0	10.5	57.3	22.6	0.0
			124	2013	27	-	-	-	-	-
			124	2018	100	6.3	12.1	34.7	57.3	0.0
			124	2019	100	6.4	11.9	21.0	67.7	0.0
			124	2020	100	5.4	11.8	44.4	39.5	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	366	2008	11.7	-	-	-	-	-
			365	2009	100	0.1	11.0	63.8	33.2	0.0
			365	2010	96.7	0.0	10.8	64.0	26.9	0.0
			365	2011	97.5	0.1	9.9	72.8	18.0	0.0
			366	2012	100	0.0	10.5	69.9	25.4	0.0
			365	2013	41.9	-	-	-	-	-
			365	2018	78.9	0.3	12.1	42.7	48.6	0.0
			365	2019	100	0.1	11.9	57.0	37.5	0.0
			366	2020	75.1	0.0	11.8	45.8	46.2	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 34. Baseline (2008 to 2013) and Operational (2018-2020) MWMxTs measured during Bull Trout life history stages in the Boulder Creek diversion reach (BDR-DVWQ).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Between Bounds	Above Upper Bound by >1°C
Bull Trout	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2008	15	-	-	-	-	-
			130	2009	100	0.2	10.4	38.5	36.2	4.6
			130	2010	92	0.0	10.8	26.7	34.2	8.3
			130	2011	100	0.2	9.9	35.4	43.8	0.0
			130	2012	100	1.3	10.5	31.5	35.4	6.2
			130	2013	0	-	-	-	-	-
			130	2018	100	0.3	12.0	23.8	43.1	19.2
			130	2019	100	0.3	11.9	20.8	27.7	31.5
			130	2020	47.7	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	214	2008	48.4	-	-	-	-	-
			213	2009	100	0.1	10.4	11.7	36.2	27.2
			213	2010	95.3	0.0	10.8	20.7	20.2	27.1
			213	2011	100	0.0	9.9	18.2	12.6	24.8
			214	2012	100	0.1	10.5	18.8	16.9	31.0
			213	2013	0.0	-	-	-	-	-
			213	2018	100	0.1	12.0	17.8	24.9	28.2
			213	2019	100	0.0	11.9	13.6	28.5	27.6
			214	2020	29.1	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	366	2008	11.7	-	-	-	-	-
			365	2009	100	0.1	11.0	56.4	36.2	0.0
			365	2010	96.7	0.0	10.8	53.0	36.0	0.0
			365	2011	97.5	0.1	9.9	66.9	27.2	0.0
			366	2012	100	0.0	10.5	61.2	30.1	0.0
			365	2013	41.9	-	-	-	-	-
			365	2018	78.9	0.3	12.1	31.9	57.3	0.0
			365	2019	100	0.1	11.9	51.0	43.0	0.0
			366	2020	75.1	0.0	11.8	39.6	54.2	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 35. Operational (2018-2020) MWMxTs measured during Cutthroat Trout life history stages in the Boulder Creek downstream reach (BDR-DSWQ).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT				
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Below Lower Bound	Between Bounds	Above Upper Bound	Above Upper Bound by >1°C
Cutthroat Trout	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2018	100	3.6	10.2	83.7	91.3	8.7	0.0	0.0
			92	2019	100	3.6	10.3	70.7	82.6	17.4	0.0	0.0
			92	2020	100	3.3	8.8	91.3	100.0	0.0	0.0	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2018	100	5.2	11.6	37.9	49.2	50.0	0.0	0.0
			124	2019	100	4.7	11.5	28.2	37.1	62.9	0.0	0.0
			124	2020	100	4.1	11.4	43.5	57.3	41.9	0.0	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2018	78.9	0.4	11.6	49.7	59.7	40.3	0.0	0.0
			365	2019	100	0.1	11.5	62.5	65.8	34.2	0.0	0.0
			366	2020	80.9	0.1	11.4	51.4	57.1	42.9	0.0	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 36. Operational (2018-2020) MWMxTs measured during Bull Trout life history stages in the Boulder Creek downstream reach (BDR-DSWQ).

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT				
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Below Lower Bound	Between Bounds	Above Upper Bound	Above Upper Bound by >1°C
Bull Trout	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2018	100	0.4	11.6	24.6	31.5	45.4	22.3	16.2
			130	2019	100	0.6	11.5	30.0	43.1	24.6	32.3	20.8
			130	2020	63.8	5.1	11.4	0.0	0.0	34.9	65.1	33.7
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2018	100	0.1	11.6	14.1	43.7	27.2	29.1	28.2
			213	2019	100	0.1	11.5	12.6	38.8	30.8	30.4	27.6
			214	2020	39.0	-	-	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2018	78.9	0.4	11.6	34.7	49.7	50.3	0.0	0.0
			365	2019	100	0.1	11.5	55.9	62.5	37.5	0.0	0.0
			366	2020	80.9	0.1	11.4	43.6	51.4	48.6	0.0	0.0

Blue shading indicates exceedance of the lower bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates exceedance of the upper bound of the BC WQG optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

4.2.8. Frazil Ice

Air temperature recorded at Callaghan Valley and Pemberton Airport weather stations was monitored from March 2020 to February 2021. The lowest monthly average and instantaneous air temperatures in Year 3 at Callaghan Valley and Pemberton airport weather stations were recorded in February 2021 (averages of -3.0°C and -2.6°C with instantaneous minimums of -15.1°C and -11.2°C respectively).

Analysis of air temperature data from Pemberton Airport weather station confirmed there was a single occurrence of six consecutive days of temperatures averaging <-5°C in February 2021 (Table 37, Figure 15). In addition, one occurrence of seven consecutive days of temperatures averaging <-5°C in February 2021 was observed at the Callaghan Valley Station (Table 37, Figure 16).

Boulder Creek and Upper Lillooet HEFs were shut down on February 11th and 12th, respectively, due to low flow (pers. comm. Katamay-Smith 2021). As per the frazil ice monitoring protocol, site photographs were collected by operations staff for Upper Lillooet and Boulder Creek on February 11 and 12, 2021. Representative photos of the ice conditions on Boulder Creek on February 11, 2021 are shown in Figure 17 to Figure 19. The Boulder Creek facility shut down on February 11, 2021 therefore subsequent frazil ice assessments were not required. Representative photos of the ice conditions on Upper Lillooet on February 12, 2021 are shown in Figure 20 to Figure 22. The Upper Lillooet facility was shutdown on February 12, 2021 therefore subsequent frazil ice assessments were not required. Photographs were reviewed for both facilities and it was determined that conditions did not warrant a site visit as frazil ice was not detected.

Table 37. Summary of dates when air temperature was less than -5°C for at least three consecutive days during Year 3 (October 2020 to February 2021).

Weather Station Air Temperature	Year	Start Date	End Date	Length (days)
Callaghan Valley	2021	8-Feb	14-Feb	7
Pemberton Airport	2021	9-Feb	14-Feb	6

Figure 15. Average daily air temperature data from October 2020 to February 2021 at Callaghan Valley air temperature monitoring station. Note the threshold is met when air temperature are less than -5°C for at least three consecutive days. This figure is inclusive of those three days.

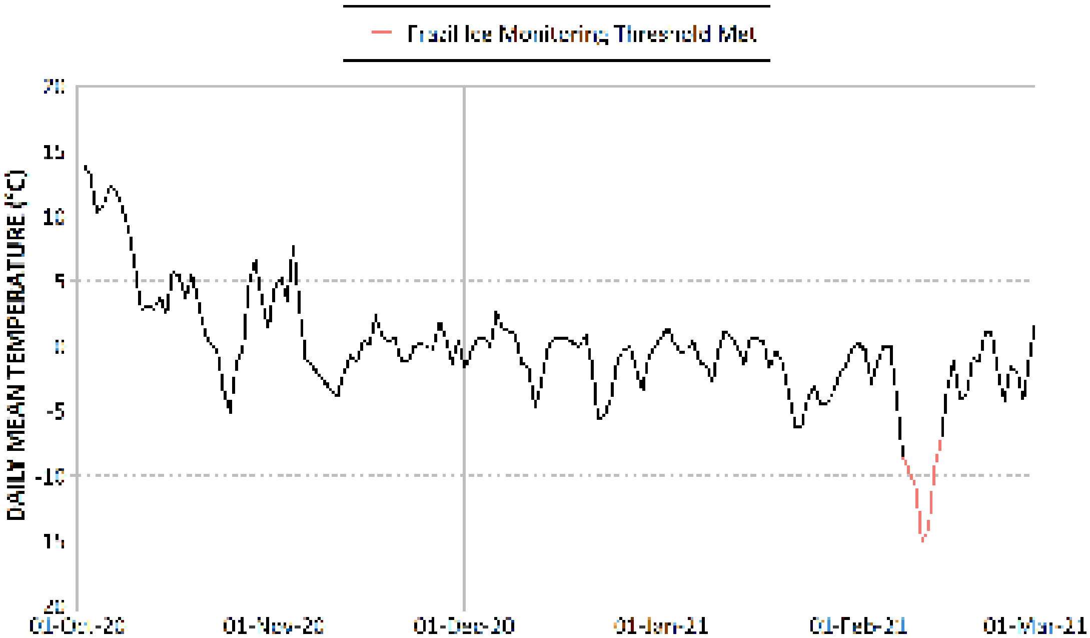


Figure 16. Average daily air temperature data from October 2020 to February 2021 at Pemberton Airport air temperature monitoring station. Note the threshold is met when air temperature are less than -5°C for at least three consecutive days. This figure is inclusive of those three days.

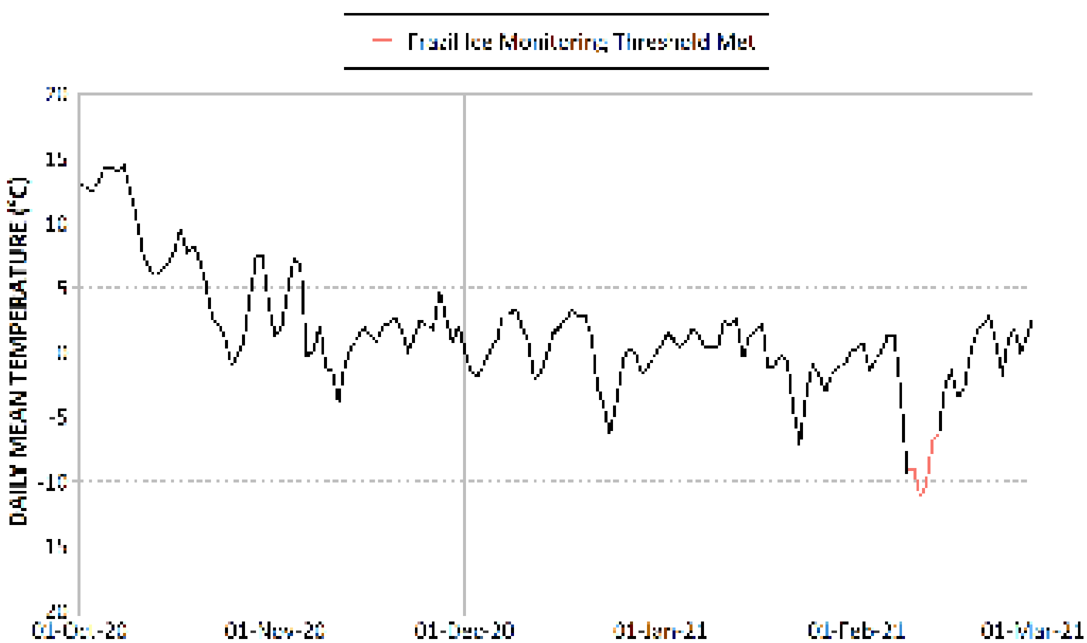


Figure 17. Looking upstream at Boulder Creek diversion on February 11, 2021.

Figure 18. Looking river right to river left at Boulder Creek on February 11, 2021.

Figure 19. Looking river right to river left at Boulder Creek diversion on February 11, 2021.

Figure 20. Looking upstream at Upper Lillooet diversion reach from the tailrace on February 12, 2021.

Figure 21. Looking river right to river left at Upper Lillooet diversion on February 12, 2021.

Figure 22. Looking downstream at Upper Lillooet from the tailrace on February 12, 2021.

4.3. Fish Community

4.3.1. Adult Migration and Distribution

4.3.1.1. Bull Trout Angling Surveys

Habitat summaries and representative photographs of angling sites in the Upper Lillooet River, Boulder Creek, and North Creek are presented in Appendix I. Capture results from Year 3 (2020) angling surveys are presented in Table 38 and site-specific results, individual fish data, and monitoring site locations are provided in Appendix I and Map 5. For reference, Bull Trout with fork lengths greater than 370 mm have been found to have a high probability (>0.8) of undergoing seasonal migrations (Monnot *et al.* 2008) and are considered to be migratory adults. As observed during baseline studies, the presence of such large Bull Trout in both the Upper Lillooet River and Boulder Creek suggests that a proportion of these fish are migratory.

Upper Lillooet River

A total of six Bull Trout were captured during angling surveys in Year 3, five in the diversion reach and one in the tailrace (Table 38). No Bull Trout were captured in the downstream reach. One Bull Trout (20%) captured in the diversion reach was sexually mature. Captured Bull Trout ranged from 178 mm to 407 mm in fork length, with the largest fish captured in the diversion reach (Table 39). No barriers to migration were observed in the 500 m of the lower diversion reach immediately upstream of the powerhouse during angling surveys. The absence of Bull Trout holding below the powerhouse, and detection of them in the diversion reach, suggests that movement into the diversion reach was not inhibited by operations in 2020. In addition, two Cutthroat Trout were captured during surveys (251 mm at ULL-DVAG19 and 116 mm at ULL-DSAG09; see Map 5 for locations of monitoring sites). These fish were not included in catch per unit effort calculations.

A single Bull Trout recapture was caught in 2020. This fish had been captured and tagged at ULL-DVAG15 in 2019 and had a fork length of 279 mm and weight of 210 grams. In 2020, this fish was recaptured at ULL-TRAG01 and had a fork length of 283 mm and a weight of 210 grams. These two monitoring sites are less than 100 meters apart (Map 5), which tentatively suggests that Bull Trout may use similar spawning and/or holding habitat each year; however, recapture location information for the Upper Lillooet River comes from a single recaptured fish.

Boulder Creek

A total of 38 Bull Trout were captured during angling surveys in Year 3, 17 in the diversion reach, 7 in the tailrace, and 14 in the downstream reach (Table 38). Of these, 29% were sexually mature in the diversion reach and tailrace, and 21% were sexually mature in the downstream reach. Captured Bull Trout ranged from 167 mm to 485 mm in fork length, with the largest fish captured in the diversion reach (Table 39). No barriers to migration were observed during the assessment of fish passage and upstream access conducted during angling surveys within the lower 1.3 km of Boulder Creek. The absence of Bull Trout holding below the powerhouse and detection of them in the diversion reach suggests that movement into the diversion reaches was not inhibited by operations in 2020.

Two Bull Trout recaptures were caught in 2020. One fish was captured in 2018 (290 mm, 243 grams), 2019 (300mm, 243 grams), and 2020 (340 mm, 400 grams) at the same sampling location each year (BDR-DSAG06; Map 5). The second recapture was caught in 2019 (205 mm, 91 grams) and again in 2020 (256 mm, 180 grams) at BDR-TRAG01. Similar to recapture results from the Upper Lillooet River, these recapture observations on Boulder Creek suggest Bull Trout may use the same spawning and/or holding habitat each year.

North Creek

A total of 43 Bull Trout were captured in North Creek, of which 57-78% were sexually mature (Table 38). Captured Bull Trout ranged from 162 mm to 575 mm in fork length (Table 39). Sexual maturity, CPUE, and lengths were typically greater than those of fish captured in both Upper Lillooet River and Boulder Creek. No previously captured Bull Trout were recaptured on North Creek.

Table 38. Summary of Bull Trout capture data during angling surveys conducted in the Upper Lillooet River, Boulder Creek, and North Creek in fall of 2020.

Stream	Date	Project Area	# of Sites	Effort (rod hrs)	Bull Trout Captures	CPUE [1] (Bull Trout/hr)	% Sexually Mature
Upper Lillooet River	16-Sep	Diversion	2	2.0	3	1.5	0%
	16-Sep	Tailrace	1	1.0	0	0.0	n/a
	16-Sep	Downstream	3	3.0	0	0.0	n/a
	2-Oct	Diversion	2	2.0	2	1.0	50%
	2-Oct	Tailrace	1	1.0	1	1.0	0%
	2-Oct	Downstream	3	3.0	0	0.0	n/a
	21-Oct	Diversion	2	2.0	0	0.0	n/a
	21-Oct	Tailrace	1	1.0	0	0.0	n/a
	21-Oct	Downstream	3	3.0	0	0.0	n/a
2020 Total:		**Diversion**	**6**	**6.0**	**5**	**0.8**	**20%**
		Tailrace	**3**	**3.0**	**1**	**0.3**	**0%**
		Downstream	**9**	**9.0**	**0**	**0.0**	**n/a**
Boulder Creek	15-Sep	Diversion	4	4.0	2	0.5	0%
	15-Sep	Tailrace	1	1.3	0	0.0	n/a
	15-Sep	Downstream	4	3.8	5	1.3	0%
	1-Oct	Diversion	4	4.0	5	1.3	20%
	1-Oct	Tailrace	1	1.0	1	1.0	100%
	1-Oct	Downstream	3	3.0	5	1.7	0%
	20-Oct	Diversion	4	4.0	10	2.5	40%
	20-Oct	Tailrace	1	1.0	6	6.0	17%
	20-Oct	Downstream	3	3.0	4	1.3	75%
2020 Total:		**Diversion**	**12**	**12.0**	**17**	**1.4**	**29%**
		Tailrace	**3**	**3.3**	**7**	**2.1**	**29%**
		Downstream	**10**	**9.9**	**14**	**1.4**	**21%**
North Creek	17-Sep	N/A	6	6.1	18	3.0	61%
	30-Sep	N/A	6	6.0	18	3.0	78%
	19-Oct	N/A	6	6.0	7	1.2	57%
2020 Total:		**N/A**	**18**	**18.1**	**43**	**2.4**	**67%**

[1] Two Cutthroat Trout were captured during surveys. First Cutthroat Trout was captured on October 2, 2020 at ULL-DVAG19 (251 mm, 120 grams). Second Cutthroat Trout was captured October 21, 2020 at ULL-DSAG09 (116 mm, 9.8 grams). These fish were not included in catch per unit effort calculations.

Table 39. Summary of fork length, weight, and condition factor for Bull Trout captured during angling surveys in the Upper Lillooet River, Boulder Creek, and North Creek in fall of 2020.

Stream	Project area	Fork Length (mm)				Weight (g)				Condition Factor (K)			
		n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Upper Lillooet River	Diversion	5	244	178	407	5	216	59	700	5	1.05	0.96	1.24
	Tailrace	1	283	283	283	1	210	210	210	1	0.93	0.93	0.93
	Downstream	0	-	-	-	0	-	-	-	0	-	-	-
	Total:	6	251	178	407	6	215	59	700	6	1.03	0.93	1.24
Boulder Creek	Diversion	17	267	172	485	17	272	60	1220	17	1.03	0.58	1.18
	Tailrace	7	269	192	379	7	228	76	459	7	1.03	0.84	1.13
	Downstream	12	263	167	480	12	247	40	950	12	0.97	0.73	1.14
	Total:	36	266	167	485	36	255	40	1220	36	1.01	0.58	1.18
North Creek	N/A	43	321	162	575	37	444	47	2004	37	1.00	0.84	1.15
	Total:	43	321	162	575	37	444	47	2004	37	1.00	0.84	1.15

4.3.1.1. Tributary Bank Walk Bull Trout Spawner Surveys

A summary of effort and fish observations during bank walk spawner surveys in Alena Creek and 29.2 km Tributary in the fall of 2020 are presented in Table 40. Surveyed distances ranged from 1,750 m to 2,300 m in Alena Creek, and were 724 m in 29.2 km Tributary. A single live Bull Trout (400 mm) was observed in 29.2 km Tributary on September 30, 2020. One redd was identified on this survey date which was identified as a Bull Trout redd based on spawn timing and the observation of Bull Trout during the survey. Also, one live unidentified trout (250 mm) was observed on September 30, 2020. In Alena Creek, no live adults, carcasses, or redds were observed during any of the three surveys.

Table 40. Summary of results from spawner surveys conducted in Alena Creek and 29.2 km Tributary in fall of 2020.

Stream	Date	Survey Time (hh:mm)	Survey Distance (m)	Number Observed[1]								
				Live Adults[2]			Adult Carcasses			Redds		
				BT	CT	CO	BT	CT	CO	BT	CT	CO
Alena Creek	16-Sep-20	01:30	1,750	0	0	0	0	0	0	0	0	0
	2-Oct-20	01:27	2,300	0	0	0	0	0	0	0	0	0
	21-Oct-20	01:31	2,300	0	0	0	0	0	0	0	0	0
	Total:	**04:28**	**6,350**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
29.2 km Tributary	17-Sep-20	01:03	724	0	0	0	0	0	0	0	0	0
	30-Sep-20	00:55	724	1	0	0	0	0	0	1	0	0
	19-Oct-20	00:55	724	0	0	0	0	0	0	0	0	0
	Total:	**02:53**	**2,172**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**

[1] BT = Bull Trout, CT = Cutthroat Trout, CO = Coho Salmon

[2] One live unidentified trout (~250mm) was observed on September 30, 2020

4.3.1.2. Comparison Among Years

Angling Catch per Unit Effort (CPUE)

Upper Lillooet River

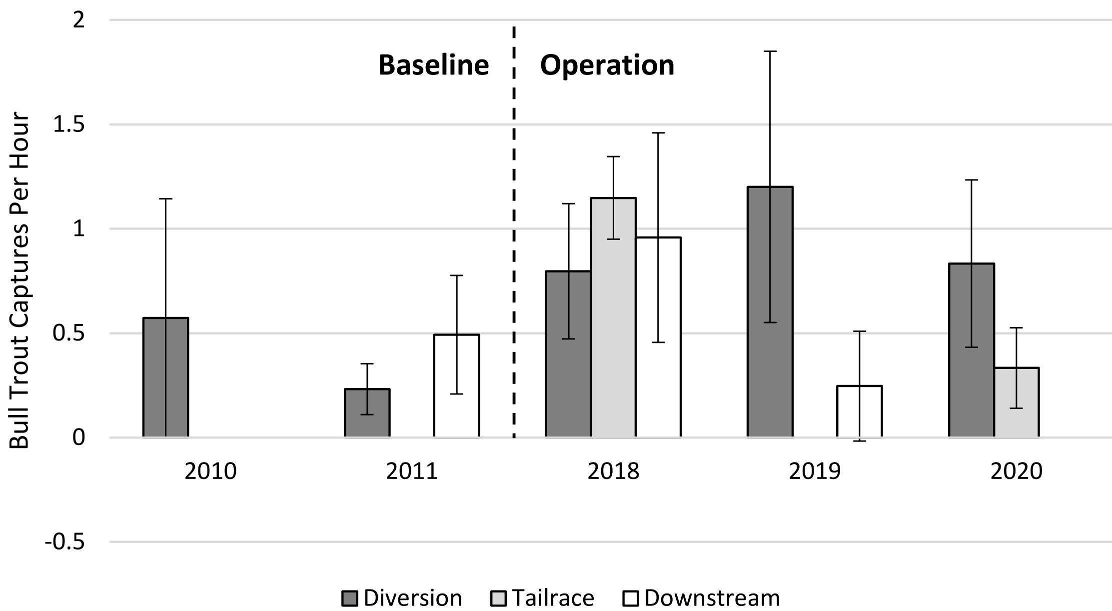
Catch per unit effort (CPUE) in the diversion reach has remained relatively consistent during operations, ranging from 0.80 to 1.20 fish per hour in Years 1 to 3, whereas during the baseline years, CPUE was lower and differed in the two years (average of 0.57 and 0.23 fish per hour in 2010 and 2011, respectively) (Table 41, Figure 23). No trend in CPUE was evident in any of the sampling locations over time during operational monitoring. CPUE in the tailrace has ranged from 0 to 1.15 fish per hour during operations. CPUE in the downstream reach was variable in both baseline (zero to 0.49 fish per hour) and operational years (zero to 0.96 fish per hour).

The continued presence of large-bodied spawning Bull Trout in the diversion reach and lack of buildup of Bull Trout in the downstream reach or at the tailrace provides evidence that movement into the diversion reaches has not been inhibited by operations. Note that the facility was shutdown during the expected peak spawning migration period in 2018 and the relatively high number of Bull Trout detected in the downstream reach in 2018 do not represent a Project effect on movement into the diversion reach as flows would have been unaffected by operations.

Table 41. Comparison of bull trout captures and mean catch per unit effort between baseline years and operational years to date, at diversion, tailrace, and downstream monitoring sites on the Upper Lillooet River.

Metric	Reach	Baseline		Operational		
		2010	2011	2018	2019	2020
Sites Sampled	Diversion	3	10	6	6	6
	Tailrace	-	-	3	3	3
	Downstream	2	4	9	8	9
Captures	Diversion	4	3	6	7	5
	Tailrace	-	-	4	0	1
	Downstream	0	2	10	2	0
Effort (hr)	Diversion	3.9	11.2	8.0	7.1	6.0
	Tailrace	-	-	3.6	3.4	3.0
	Downstream	2.1	4.0	11.0	8.0	9.0
Mean CPUE (fish/hr)	Diversion	0.57	0.23	0.80	1.20	0.83
	Tailrace	-	-	1.15	0.00	0.33
	Downstream	0.00	0.49	0.96	0.25	0.00

Figure 23. Comparison of bull trout captures and mean catch per unit effort between baseline years and operational years to date, at diversion, tailrace, and downstream monitoring sites on the Upper Lillooet River. Error bars shown are standard error.



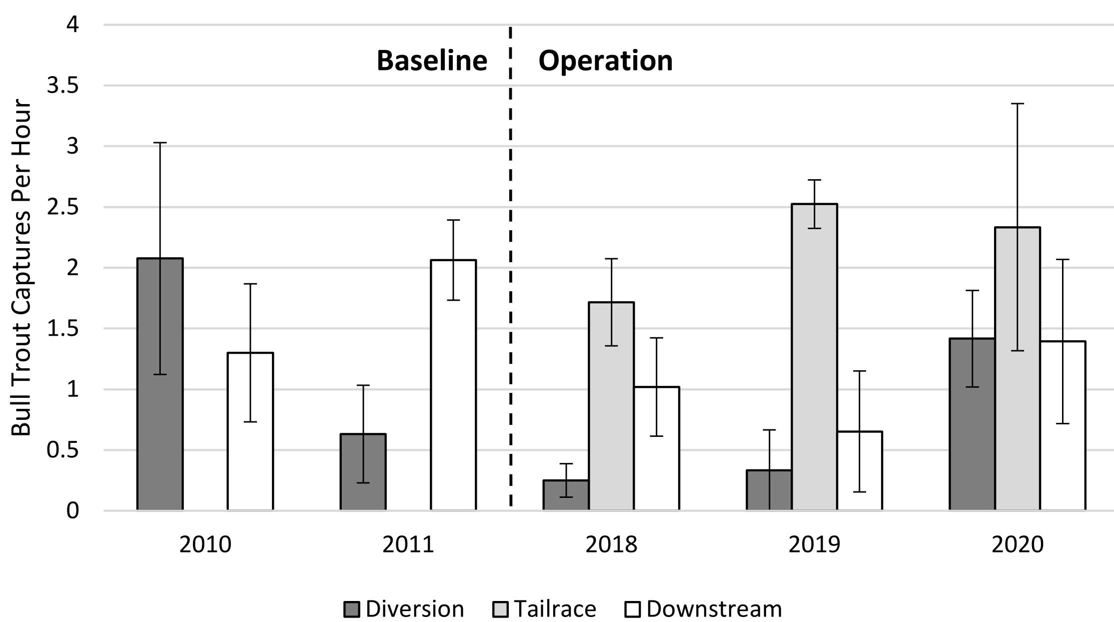
Boulder Creek

CPUE in the Boulder Creek diversion reach differed in the two baseline years (average of 2.08 and 0.63 fish per hour in 2010 and 2011, respectively) (Table 42, Figure 24). In Year 1, CPUE was 0.25 fish per hour in the diversion reach, which is notably lower than CPUE in the baseline years; however there has been an increasing trend in subsequent operational years (average of 0.33 and 1.42 fish per hour in 2019 and 2020, respectively). CPUE in the tailrace has ranged from 1.72 to 2.53 fish per hour during operations. CPUE in the downstream reach was greater during baseline (1.30 to 2.06 fish per hour) than operational (0.65 to 1.39 fish per hour) monitoring to date. Similar to observations in the Upper Lillooet River, captures in the diversion reach suggests that access was not inhibited in operational years.

Table 42. Comparison of bull trout captures and mean catch per unit effort between baseline years and operational years to date, at diversion, tailrace, and downstream monitoring sites on Boulder Creek.

Metric	Reach	Baseline		Operational		
		2010	2011	2018	2019	2020
Sites Sampled	Diversion	2	6	11	9	12
	Tailrace	-	-	3	3	3
	Downstream	4	7	12	11	10
Captures	Diversion	8	4	4	3	17
	Tailrace	-	-	6	8	7
	Downstream	5	17	16	8	14
Effort (hr)	Diversion	6.6	7.8	12.9	9.1	12.0
	Tailrace	-	-	3.3	3.2	3.3
	Downstream	4.1	8.9	15.5	11.6	9.9
Mean CPUE (fish/hr)	Diversion	2.08	0.63	0.25	0.33	1.42
	Tailrace	-	-	1.72	2.52	2.33
	Downstream	1.30	2.06	1.02	0.65	1.39

Figure 24. Comparison of bull trout captures and mean catch per unit effort between baseline years and operational years to date, at diversion, tailrace, and downstream monitoring sites on Boulder Creek. Error bars shown are standard error.



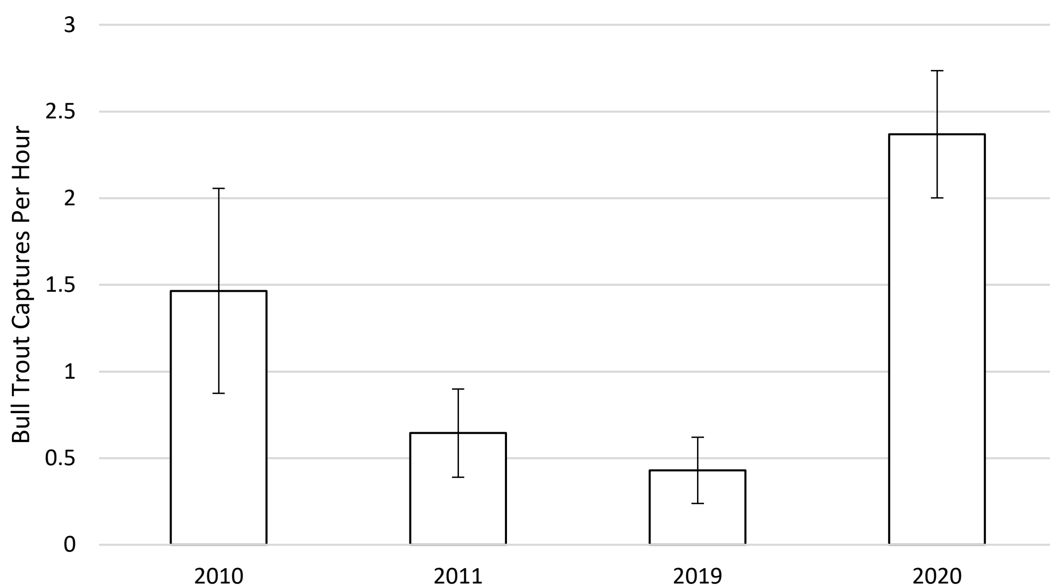
North Creek

Angling in North Creek was conducted in 2010 and 2011 during the baseline period and in years 2 and 3 of operations (2019 and 2020[2]). Catch per unit effort in Year 3 (2020) was 2.37 fish per hour, which was notably higher than in all previous monitoring years (Table 43, Figure 25). Catch per unit effort was lowest in 2019 and intermediate during the two baseline years (1.47 and 0.64 fish per hour in 2010 and 2011, respectively).

Table 43. Comparison of bull trout captures and mean catch per unit effort between baseline years and operational years to date, at monitoring sites on North Creek.

Metric	Reach	Baseline		Operational		
		2010	2011	2018	2019	2020
Sites Sampled	N/A	5	7	-	12	18
Captures	N/A	9	5	-	4	43
Effort (hr)	N/A	10.9	7.7	-	11.1	18.1
Mean CPUE (fish/hr)	N/A	1.47	0.64	-	0.43	2.37

Figure 25. Comparison of bull trout captures and mean catch per unit effort between baseline years and operational years to date, at monitoring sites on North Creek. Error bars shown are standard error.



[2] Angling in North Creek was included following recommendations in Year 1 to avoid confusion on sampling requirements due to discrepancy in the OEMP text and tables (Harwood *et al.* 2017).

Tributary Bank Walk Spawner Surveys

Tributary bank walk spawner surveys were conducted on Alena Creek and on the 29.2 km Tributary in September and October during the Bull Trout spawning period in one baseline year (2011) and three operational years (2018 to 2020). Nine Bull Trout were observed over a distance of 700 m during a single survey on Alena Creek in 2011 (Table 44). Two surveys were conducted in Year 1 (2018) and three surveys were conducted in years 2 and 3 (2019, 2020) of operations, and peak counts in these years were two, one, and zero Bull Trout, respectively. Survey distances in years 1 through 3 ranged from 1,631 m to 2,300 m (averaging 1,675 m in Year 1 and 2,117 m in Year 2 and Year 3). Thus, survey distances were notably longer during operational years than during the single baseline survey (700 m).

A single spawner survey was conducted on 29.2 km Tributary in 2011 during which eight Bull Trout were observed over 560 m (Table 45). Three surveys were completed in each of years 1 through 3 of operations and peak counts in these years were two, zero, and one Bull Trout, respectively. Survey distance in Years 1 through 3 was 724 m, which is slightly greater than the 560 m survey distance during baseline.

Peak counts observed in operational years 1 through 3 on Alena Creek and 29.2 km Tributary were lower than baseline counts.

Table 44. Comparison of adult Bull Trout observed during tributary bank walk spawner surveys between baseline (2011) and operational years (2018 to 2020) to date on Alena Creek.

Date	Survey Time (hh:mm) [1]	Survey Distance (m)	Adult Bull Trout Observed		
			Live	Carcasses	Redds
04-Oct-11	n/c	700	9	0	0
14-Sep-18	01:28	1,631	0	0	0
11-Oct-18	04:07	1,719	2	0	0
17-Sep-19	01:30	1,750	0	0	0
01-Oct-19	01:53	2,300	1	0	1
22-Oct-19	02:00	2,300	0	0	0
16-Sep-20	01:30	1,750	0	0	0
02-Oct-20	01:27	2,300	0	0	0
21-Oct-20	01:31	2,300	0	0	0

[1] n/c = not collected

Table 45. Comparison of adult Bull Trout observed during tributary bank walk spawner surveys between baseline (2011) and operational years (2018 to 2020) to date on 29.2 km Tributary.

Date	Survey Time (hrs) [1]	Survey Distance (m)	Adult Bull Trout Observed		
			Live	Carcasses	Redds
04-Oct-11	n/c	560	8	0	0
13-Sep-18	01:19	724	0	0	0
28-Sep-18	00:45	724	0	0	0
09-Oct-18	00:45	724	2	0	0
18-Sep-19	00:56	724	0	0	0
29-Sep-19	00:58	724	0	0	0
23-Oct-19	00:55	724	0	0	0
17-Sep-20	01:03	724	0	0	0
30-Sep-20	00:55	724	1	0	1
19-Oct-20	00:55	724	0	0	0

[1] n/c = not collected

4.4. Wildlife Species Monitoring

4.4.1. Harlequin Ducks

No Harlequin Ducks were observed during spot checks in 2020 (Table 46, Map 12). The headpond was drained on May 26, 2020 (it was drained between May 22 and July 20 due to a BC Hydro forced shutdown); however, it had not been drained earlier in May when Harlequin Ducks had also not been observed. Harlequin Ducks had also not been observed during spot checks in 2019 (Appendix D of Harwood *et al.* 2021). In 2018 (Year 1), two adult females had been detected in the headpond on May 3 (Regehr *et al.* 2019) during a pair survey. One other species of waterfowl was observed during spot checks in 2020: 10 Barrow's Goldeneye (*Bucephala islandica*) were seen in the headpond on May 12.

Harlequin Ducks were also not incidentally observed in the Project area in 2020; however, four unidentified ducks were observed in the headpond on April 20, 2020 (Appendix J), that could have been Harlequin Ducks. In 2018, one pair of Harlequin Ducks was documented present on the same date (i.e., April 20; Regehr *et al.* 2019).

No Harlequin Ducks were confirmed to have used the Project area in 2020. Given that the headpond was drained in May when Harlequin Ducks have been documented in the headpond in the past, it is possible that they were disturbed. Based on the date and location of the observation, it is possible that the four unidentified ducks seen incidentally on April 20 were Harlequin Ducks.

During the baseline period, Harlequin Duck observations from locations comparable to those surveyed during monitoring spot checks included two pairs (four birds) documented within the (then proposed) headpond location on May 19 in 2011 and one female adjacent to the powerhouse location in June 2009. Brood surveys in August have not resulted in Harlequin Duck observations at the locations visited during spot checks in any year (baseline or post-construction), which may indicate that Harlequin Ducks do not breed in the vicinity of the Project area, although the species can be more difficult to detect at that time of year because males (which are most visible) leave breeding streams when females begin to incubate, females with young are cryptic and secretive (can be difficult to spot), and females that fail at breeding leave the area. However, two female-like Harlequin Ducks were seen incidentally in September of 2018 that may have been a family group (adult female and juvenile) near the end of the breeding season.

Although no Harlequin Ducks were detected during surveys in Year 2 and Year 3, overall counts (surveys plus incidental observations) have been similar at the two spot check locations in these years post-construction to what was observed prior to Project construction (assuming the unidentified ducks seen in 2020 were Harlequin Ducks). However, it should be noted that surveys were designed to allow comparison among years, and although incidental observations aid in interpretation of results, these are not comparable across years due to differences in effort. It should also be noted that surveys in 2020 (and likely also in 2019) were done with surveillance cameras rather than in person as required by the protocols (Appendix E), and this may affect comparability of results. Although the field of view of the surveillance cameras is relatively large, the cameras are not located at the vantage points specified in the protocols (Table 1 of Appendix E), and when surveys are done with cameras, not all locations where Harlequin Ducks may be feeding or resting in the area may be visible (e.g., the sides of the headpond or the tailrace facing away from the camera may not be visible in the camera's field of view). It is also less likely to detect birds diving or flying through the area by camera. In contrast, when the surveys are done in person, the surveyor can ensure that all locations where Harlequin Ducks may be concealed from the camera have been adequately viewed, that enough time is taken to detect diving birds (that may be underwater for periods of time), and that riparian and shoreline areas, where birds may be concealed or resting, are well scanned. Results from surveys in the next two years should help to evaluate if there is a change in use of the area by Harlequin Ducks, especially if surveys are done in future as per the protocols (i.e., surveys done in person at specified vantage points with spotting scope or binoculars).

Table 46. Results of Harlequin Duck spot check surveys at the ULR HEF intake and powerhouse in Year 3 (2020).

Survey Type	Date	Infrastructure	Spot Check Vantage Point UTM Coordinates (Zone 10U)		Harlequin Ducks Observed	Other Waterbirds Observed	Comments
			Easting	Northing			
pair	12-May-2020	intake	466156	5614170	0	10 Barrow's Goldeneye (*Bucephala islandica*)	
		powerhouse	468416	5611634	0	-	
	18-May-2020	intake	466156	5614170	0	-	
		powerhouse	468416	5611634	0	-	
	26-May-2020	intake	466156	5614170	0	-	headpond was drained
		powerhouse	468416	5611634	0	-	
brood	5-Aug-2020	intake	466156	5614170	0	-	
	10-Aug-2020	intake	466156	5614170	0	-	
	15-Aug-2020	intake	466156	5614170	0	-	

4.4.2. Species at Risk & Regional Concern

Species at risk and of regional concern incidentally observed and recorded by Ecofish personnel and Project operators in the Project area in 2020 are summarized in Appendix J (note that these results do not include observations of species at risk and regional concern detected by the wildlife cameras in the vicinity of the Boulder Creek HEF intake installed for Mountain Goat mitigation effectiveness monitoring, which are summarized in Section 4.5.3.1). Most of the wildlife species observed incidentally in 2020 have also been recorded in previous years (e.g., Moose, Mule Deer, Grizzly Bear, American Black Bear (*Ursus americanus*), Mountain Goat (Figure 26), Bobcat (*Lynx rufus*), Cougar, Grey Wolf, Bald Eagle (*Haliaeetus leucocephalus*)); however, three species were detected that were not recorded during monitoring previously: Hoary Marmot (*Marmota caligata*)(recorded at the Boulder Creek HEF intake access road on June 17), Fisher (*Pekania pennanti*)(recorded by wildlife camera ULL-CAM15 on April 11; Figure 27), and Roosevelt Elk (*Cervus elaphus roosevelti*)(recorded at km 38.5 along the Lillooet River FSR on September 27). Wolverine (*Gulo gulo luscus)* were not detected in 2020 and have been detected in all other years.

As discussed in Year 2, to reduce the potential for human-wildlife conflict, observations of large mammals, especially Grizzly Bears and Moose along the Lillooet River FSR, are given special consideration by Project operations (i.e., sightings are recorded and shared among Project operators to raise awareness of where Grizzly Bears and Moose are more likely to be encountered when working outdoors and driving). The sighting of a Roosevelt Elk along the Lillooet River FSR suggests that this species should be added to the list of sightings given special consideration to avoid human-wildlife conflict (e.g., wildlife-vehicle collision).

Figure 26. Mountain Goat and kid photographed by ULL-CAM15 on April 21, 2020.

Figure 27. Fisher photographed by ULL-CAM15 on April 11, 2021.

4.5. <u>Wildlife Habitat Monitoring</u>

4.5.1. Habitat Restoration – Amphibian Habitat

The spot check conducted on August 24, 2020, at ULL-ASTR04, where geotextile had been found exposed in Year 1, indicated that a small portion (~ 0.8 m long) of geotextile had become exposed at the edge of river right (Figure 28), since having been covered in 2019. This small section was re-covered (with cobble found on site) on the day of the spot check (Figure 29). However, most of the geotextile that had been exposed in 2018 (see figures 33 and 34 in Regehr *et al.* (2019)) remained covered. Further, it was apparent that extra cobble had been added to the substrate in 2019, resulting in substantial improvements to the geotextile covering in the area.

Figure 28. Exposed geotextile within the stream channel at ULL-ASTR04IM on August 24, 2020.

Figure 29. Location where geotextile had been exposed adjacent to the stream channel, after covering exposed section with cobble by hand, on August 24, 2020.

4.5.2. Habitat Restoration – Mammal Habitat

Results of mammal habitat restoration compliance monitoring for Grizzly Bear, Moose, and Mule Deer at restoration monitoring sites that were reassessed in Year 3 are presented in (Table 47) and the details of compliance monitoring results, along with photographs, are presented in Appendix K. Locations of restoration monitoring sites are shown on Map 8.

Only at two sites reassessed in Year 3 in Grizzly Bear habitat were the vegetated screens assessed to be adequate: one is located along the South Lillooet River (ULH-MAMCM18) and the other (ULH-MAMCM25) is located approximately 13 km south of this location (Map 9). At all other sites reassessed in Year 3, the screens had not yet attained the required 5 m height (and in some cases width) (Table 47).

Most Moose habitat vegetated screens (4 of 6) had achieved height and width requirements in Year 1 (Table 66 in Regehr *et al.* 2019) and were not reassessed in Year 3. The vegetated screens at the two remaining sites (ULH-MAMCM12 and ULH-MAMCM14; Map 10) reassessed in Year 3 did not meet height requirements (Table 47).

Vegetated screens at two sites reassessed in Year 3 in Mule Deer habitat met screen height and width requirements. One of these had been established to also monitor requirements for Grizzly Bear habitat (ULH-MAMCM25; see above) and the second one (ULH-MAMCM11) is located on the north side of the Upper Lillooet River (Map 11). At all other sites reassessed in Year 3, the screens had not yet attained the required 5 m height (and in some cases width) (Table 47).

Monitoring in Year 5 is recommended for sites at which vegetated screens have not yet achieved required dimensions; however, this recommendation will be reconsidered for each site in Year 4, based on an upcoming assessment of site-specific transmission line safety constraints for vegetated screen height. Growth of existing vegetation is expected to create an adequate screen over time at most of these sites, but at one site (ULH-MAMCM04B), little revegetation progress has been observed after two years and planting is therefore recommended in areas where growth is restricted by wood chips. In Year 1, the potential need for planting was also identified at ULH-MAMCM09 if existing vegetation had not improved by Year 3; however, although screen height was still inadequate at this location in Year 3 (average height of 2 m), vegetation height has improved since 2018 and the screen was considered on track for meeting height requirements. Of the other eight sites at which the screen heights were still more than 2 m below the target 5 m height in Year 3 (ULH-MAMCM07, ULH-MAMCM09, ULH-MAMCM10, ULH-MAMCM12, ULH--MAMCM21, ULH-MAMCM022, ULH-MAMCM023, and ULH-MAMCM024; Table 47), most are expected to achieve sufficient size naturally because woody plants are present (some of which were growing well in Year 1 but were cut down). However, as also noted in Year 1, the height of the screen may be limited by the transmission line at ULH-MAMCM24. In addition, vegetation at ULH-MAMCM02 had been destroyed in the 2015 Boulder wildfire and is slow to recover. Vegetation growth at ULH-MAMCM07 is not anticipated to occur along a 70 m wide scree slope; thus, no further monitoring at this site is recommended. Most vegetated screens have achieved the target 5 m width (exceptions are ULH-MAMCM04B, ULH-MAMCM07, ULHMAMCM09, and ULH-MAMCM21).

Table 47. Summary of vegetated screen assessments within high value mammal habitat along the transmission line in Year 3 (2020). Grey highlighting identifies sites for which no further monitoring is required.

Site	Species and Habitat[1]	Vegetated Screen Metrics[2]			Comments	Recom-mendation to Reassess in Year 5
		Average Width (m)	Average Height (m)	Average % Cover (Visibility)		
ULH-MAMCM01	Grizzly Bear - High Value	7	4	17	Partially burnt and disturbed, some natural regeneration; slow to recover from the Boulder Creek forest fire	yes
ULH-MAMCM02	Grizzly Bear - High Value	–	–	–	Site is burnt; located very high above the road; slow to recover	yes
ULH-MAMCM04B	Grizzly Bear - High Value	3	2	12	Some natural regeneration but growth is limited on the wood chips	yes
ULH-MAMCM06	Grizzly Bear - High Value Mule Deer - UWR	18	4	70	Revegetation is dense and is on track for achieving height requirement; cover is high	yes
ULH-MAMCM07	Grizzly Bear - High Value Mule Deer - UWR	3	2	12	Limited natural regeneration on the ~70 m scree slope; however, it is unlikely this area previously supported substantial vegetation and would be difficult to plant	no
ULH-MAMCM08	Mule Deer - UWR	17	4	50	Abundant regeneration; on track to meet 5 m height requirement	yes
ULH-MAMCM09	Grizzly Bear - High Value Mule Deer - UWR	4	2	6	Some vegetation has grown tall (4 m); on track for natural regeneration reaching 5 m	yes
ULH-MAMCM10	Mule Deer - UWR	11	2	15	Good natural regeneration; vegetation is expected to grow taller than 5 m over time	yes
ULH-MAMCM11	Mule Deer - UWR	11	5	50	Abundant regeneration of red alders along the road ~7m in height; vegetation screen has achieved height and width requirements	no
ULH-MAMCM12	Moose - UWR	7	2	10	Site has been disturbed; many alders and willows were cut down	yes
ULH-MAMCM14	Grizzly Bear - WHA 2-399 Moose - UWR	10	4	100	Abundant natural regeneration, dense bushes; vegetation growth is on track for 5 m height requirement	yes

[1] High value Grizzly Bear habitat is considered as Class 1 or Class 2 as identified by habitat suitability modelling (Leigh-Spencer *et al.* 2012) and confirmed in the field (Leigh-Spencer *et al.* 2013).

[2] Averages were generated for each site from three sets of measurements (width and height) or estimates (percent cover). At ULH-MAMCM02, vegetated screen measurements could not be taken due to height of the screen above the road.

Table 47. Continued (2 of 3).

Site	Species and Habitat[1]	Vegetated Screen Metrics[2]			Comments	Recom-mendation to Reassess in Year 5
		Average Width (m)	Average Height (m)	Average % Cover (Visibility)		
ULH-MAMCM17	Grizzly Bear - South Lillooet River FSR	8	4	90	Vegetation regenerating in the areas previously disturbed by Squamish Mills; vegetation is on track for height requirement	yes
ULH-MAMCM18	Grizzly Bear - South Lillooet River FSR	23	5	60	Excellent natural regeneration; vegetation screen has achieved height and width requirements	no
ULH-MAMCM19	Grizzly Bear - South Lillooet River FSR	25	4	35	Abundant natural regeneration; vegetation is well on track for 5 m height requirement	yes
ULH-MAMCM20	Mule Deer - UWR	22	6	65	Excellent regeneration; vegetation screen has achieved height and width requirements and is on track for 100% screen cover	no
ULH-MAMCM21	Grizzly Bear - High Value Mule Deer - UWR	4	1	4	Site is disturbed; trees that were ~2-3 m in height in 2018 were cut down and screen cover is low	yes
ULH-MAMCM22	Grizzly Bear - High Value	7	1	3	Site is disturbed. Shrubs that were ~2-3 m tall in 2018 were cut down	yes
ULH-MAMCM23	Grizzly Bear - High Value	8	1	4	Minimal screen height with vegetation composed mostly of ferns and thimbleberry; wood chips may be restricting growth; however, some alders, willows, and cottonwoods are regenerating naturally	yes
ULH-MAMCM24	Grizzly Bear - High Value Mule Deer - UWR	8	1	7	Moderate regeneration of abundant thimbleberry, and some willow and alder are on track for meeting height requirement; however, height will be limited by transmission line maintenance	yes
ULH-MAMCM25	Grizzly Bear - High Value Mule Deer - UWR	15	5	90	Excellent regeneration; vegetation screen has achieved height and width requirements and cover is high	no

[1] High value Grizzly Bear habitat is considered as Class 1 or Class 2 as identified by habitat suitability modelling (Leigh-Spencer *et al.* 2012) and confirmed in the field (Leigh-Spencer *et al.* 2013).

[2] Averages were generated for each site from three sets of measurements (width and height) or estimates (percent cover). At ULH-MAMCM02, vegetated screen measurements could not be taken due to height of the screen above the road.

Table 47. Continued (3 of 3).

Site	Species and Habitat[1]	Vegetated Screen Metrics[2]			Comments	Recom-mendation to Reassess in Year 5
		Average Width (m)	Average Height (m)	Average % Cover (Visibility)		
ULH-MAMCM26	Grizzly Bear - High Value Mule Deer - UWR	42	3	52	The screen on the right side of the road has filled in with natural regeneration, but there has been some cutting on the left side; vegetation is on track for height and width requirements	yes
ULH-MAMCM27	Grizzly Bear - High Value	47	4	90	Abundant regeneration; good mix of conifers and deciduous trees; on track for height requirement and 100% coverage	yes
ULH-MAMCM28	Grizzly Bear - High Value	40	3	25	Abundant regeneration; on track for meeting height requirements	yes

[1] High value Grizzly Bear habitat is considered as Class 1 or Class 2 as identified by habitat suitability modelling (Leigh-Spencer *et al.* 2012) and confirmed in the field (Leigh-Spencer *et al.* 2013).

[2] Averages were generated for each site from three sets of measurements (width and height) or estimates (percent cover). At ULH-MAMCM02, vegetated screen measurements could not be taken due to height of the screen above the road.

4.5.3. Mitigation Effectiveness – Mountain Goats at Boulder Creek

4.5.3.1. Public Access Monitoring

Results from monitoring used to evaluate the effectiveness of the Boulder Creek HEF access road gate in preventing public access to the intake area during the sensitive winter period indicate that the lock block placed on the upslope side of the gate in 2019 appears to have been successful in preventing passage around the closed gate to date. However, the gate did not always prevent motorized traffic from entering the intake area and vehicles and snowmobiles not associated with the Project were observed along the access road between February 29 and May 18, 2020 (Table 48).

Two snowmobilers accessed the intake area from the access road February 29, 2020, as documented by BDR-CAM03 (Table 48, Figure 30). Based on skis visible in the photos, the snowmobilers appeared to be looking for skiing locations. These two snowmobilers were also photographed upslope of the new access road by cameras BDR-CAM04 and BDR-CAM08 on the same date. Although the non-functionality of the gate when buried with snow had been identified in both previous monitoring years (Regehr *et al.* 2019, Harwood *et al.* 2021), members of the public had not yet been documented crossing over the gate by snowmobile. Snowmobiles have the potential to cause disturbance to Mountain Goats at wintering areas and their access of the intake area, facilitated by the Boulder Creek HEF access road, is of concern, especially since public use of the Upper Lillooet River area is anticipated to increase over time owing to ever increasing population growth and recreational use in the Sea to Sky corridor.

Two vehicles not related to the Project were photographed along the Boulder Creek HEF access road in mid-May 2020 (Table 48). The first (a grey pickup truck) was documented passing through the open gate (by BDR-CAM03; Figure 31) on May 15 and travelled along the access road (photographed by BDR-CAM02 and BDR-CAM01) on route to the intake (Table 48). It was documented returning through the gate by BDR-CAM03 twenty minutes later but was not photographed travelling past cameras BDR-CAM02 and BDR-CAM01 on the way out. The gate was open because Project personnel were at the intake on this day. The second vehicle was photographed passing by BDR-CAM02 at night on May 18, 2020 (Figure 32). This vehicle was not photographed by any other camera but must have come through the gate. The gate had been vandalized (cut through with a grinder) sometime between May 15 and May 18, 2020 (Figure 33). Lack of documentation by the other cameras may have been because it was dark, BDR-CAM03 is not located close to the gate (there are limited options for camera placement immediately adjacent to the gate), and potentially because rapidly moving objects are not always photographed by the cameras. Thus, although two public vehicles entered the intake area, both entered through an open gate (opened by Project personnel or cut open by the public) and there was no evidence that the gate can be bypassed by motorized vehicles during the snow-free period.

Figure 30. **One of two snowmobiles photographed at 11:58 at BDR-CAM03 on February 29, 2020, crossing over the gate buried in snow. These snowmobilers were also photographed at BDR-CAM04 and BDR-CAM08 at 13:05 on this day.**

Figure 31. Public vehicle entering through the open gate at 12:38 (top photo) and leaving at 12:58 (bottom photo) on May 15, 2020, as photographed by BDR-CAM03, when the gate had been opened by Project personnel accessing the intake area. This vehicle was also photographed by BDR-CAM02 and BDR-CAM01 on this date when entering the intake area.

Figure 32. Public vehicle photographed at BDR-CAM02 entering the area at 12:54 am and leaving the area at 1:00 am on May 18, 2020. The gate was vandalized (cut open) sometime between May 15 and May 18.

Figure 33. Vandalism of the gate (cut through with a grinder) across the Boulder Creek HEF access road documented by Project operators on May 22, 2020.

Table 48. Human activity that was not associated with the Project along the Boulder Creek HEF intake access road documented with remote infrared cameras during the Year 3 monitoring period (February 25 to June 15, 2020 and November 1 to December 23, 2020).

Non-Project Human Activity	Date	Time	Camera	Comments
snowmobile	29-Feb-2020	11:58	BDR-CAM03	two snowmobiles not related to the project
snowmobile	29-Feb-2020	13:05	BDR-CAM04	two snowmobiles not related to the project (same as photographed by BDR-CAM03)
snowmobile	29-Feb-2020	13:05	BDR-CAM08	two snowmobiles not related to the project (same as photographed by BDR-CAM03 and 08)
vehicle	15-May-2020	12:38	BDR-CAM03	vehicle not related to the project; this vehile was photographed again by this camera when leaving
vehicle	15-May-2020	12:40	BDR-CAM02	vehicle not related to the project (same as photographed by BDRCAM03)
vehicle	15-May-2020	12:43	BDR-CAM01	vehicle not related to the project (same as photographed by BDRCAM03 and 02)
vehicle	18-May-2020	12:54	BDR-CAM02	vehicle leaving at 1:00 am; could not see license plate; the gate was vandalized and cut open sometime after May 15
hiker	7-Jun-2020	16:57	BDR-CAM04	hiker not related to the project

4.5.3.1. Predator Monitoring

Results from predator monitoring identified three potential Mountain Goat predators within the survey area in the vicinity of the Boulder Creek HEF intake during the Mountain Goat winter and spring period (November 1 to June 15) (Table 49, Map 2). Remote infrared cameras photographed American Black Bear, Grey Wolf, and Grizzly Bear along the Boulder Creek HEF access road and/or in the vicinity of the intake. American Black Bear were photographed by BDR-CAM02 (on the access road) and by BDR-CAM06 and BDR-CAM08 (upslope of the intake and access road) on several occasions in May and June 2020 (Figure 34, Figure 35). A Grey Wolf was photographed by BDR-CAM08 on May 6, 2020 upslope of the access road (Figure 36). Two Grey Wolves were also photographed travelling along the access road on October 20 (by BDR-CAM01 and BDR-CAM02; Table 49, Figure 37), outside of the Mountain Goat winter/spring period. Grizzly Bears were documented using the access road on two days in May 2020 (Figure 38, Figure 39). They were photographed by only one wildlife camera along the access road on both days, although the other cameras were functional at that time, which may indicate that they only travelled along a relatively short portion of the road or crossed over the road.

Monitoring results to date provide some evidence of increased use of the Boulder Creek HEF intake area by main predators of Mountain Goats since Project construction. As discussed in the wildlife baseline monitoring report (Regehr *et al.* 2016), Grey Wolves and Cougars are considered main predators of Mountain Goats, and Grizzly Bear and American Black Bear are considered occasional predators (Shackleton 1999). During baseline monitoring (Regehr *et al.* 2016) and Year 1 monitoring (Regehr *et al.* 2019), the only potential Mountain Goat predators detected were Wolverine, bear, and Bobcat, all of which are considered occasional predators of Mountain Goats. Although both bear species were documented in the intake area in Year 3, they have been detected in the area previously (Grizzly Bears were not detected during baseline surveys but American Black Bears were detected in all years), and all Grizzly Bear detections in Year 3 were photographed by one camera only, suggesting that individuals were unlikely to have been using the road as a direct travel corridor to the intake. However, Grey Wolves and Cougars were not detected during baseline and Year 1 monitoring, yet Grey Wolves were detected in both Year 2 and Year 3 and Cougars were detected in Year 2. Thus, observations of Grey Wolves and Cougars during years 2 and 3 may indicate that use of the Boulder Creek HEF intake area by main Mountain Goat predators has increased since access road construction and that some time was required (one year) to discover the road and begin to use it. However, Cougars, which were detected on two occasions in 2019 (November and December) both on and off the road, were not detected in Year 3; thus, there is little evidence at present that Year 2 Cougar observations represent increased species presence in the area.

Whether monitoring results indicate that Grey Wolves have begun to use the access road in the last two years to access the Boulder Creek HEF intake area and therefore pose a greater risk to Mountain Goats during the winter/spring period is not clear. In Year 2, which was the first year that Grey Wolves had been detected in the vicinity of the intake, wolves were detected on the access road (passing by both BDR-CAM01 and BDR-CAM02 within a short period of time on the same day) in

March 2019, although snow was present on the road at that time (Harwood *et al.* 2021). In Year 2, wolves were also detected upslope of the access road (by BDR-CAM04) in January. However, in Year 3, the only Grey Wolf record during the Mountain Goat winter/spring period was off the access road; thus, the wolf photographed by BDR-CAM08 in May of Year 3 may have accessed the area from a different route. The wolves travelling along the access road in Year 3 were photographed on October 20, which is outside of the sensitive winter period. Nevertheless, this date is only 10 days from the start of the winter period and this record may still provide evidence that wolves have gained familiarity with the access road. Wolves are most likely to gain from the access road when there is little or no snow on the road or when the snow has been compacted by snowmobile traffic (in deep snow there would be little advantage to using an open road as an access, and travel through the forest may be easier); thus the early part of the winter period (prior to substantial snowfall), or periods of time following snowmobile access during winter, may be when wolf access is most likely to be increased. Results to date suggest that although Grey Wolves have been detected in the intake area more frequently post-construction than pre-construction, the use made of the access road by wolves appears to be slight (few detections along the road during the winter/spring period). However, as discussed in both the Year 1 and Year 2 reports, comparison among periods is difficult due to typically low frequency of predator detections which increases the need for data collection.

Mountain Goats were not documented by wildlife camera in Year 3 whereas they were detected in all other years. It is possible that Mountain Goat use of the intake area has decreased due to activity at the intake area; however, Mountain Goat detections in previous years were infrequent, thus comparison among periods is difficult. Mountain Goats were only observed in the vicinity of the Boulder Creek HEF access road once during baseline surveys (Regehr *et al.* 2019), and only Mountain Goat sign was detected in the vicinity of the Boulder Creek HEF intake in Year 1 (wildlife cameras did not photograph Mountain Goats in Year 1; Regehr *et al.* 2019). In Year 2, Mountain Goats were detected during the winter period by four cameras on three dates (Table 63 in Harwood *et al.* 2021).

Some of the cameras installed on the survey transects (intended to replace the snow-tracking surveys initiated in Year 1) were not functioning as intended throughout the entire winter/spring monitoring period in Year 3, creating gaps in the data record. Specifically, BDR-CAM05 was not well aimed between April 23 and May 12, and the camera lens was partially obstructed on BDR-CAM06 from October 22 to December 23 and on BDR-CAM08 from April 19 to May 12. Two of the cameras along the access road (BDR-CAM01 and BDR-CAM02) were also not functional for periods of time; however, BDR-CAM03, which is also along the access road was functional the entire period.

The only wildlife species other than Mountain Goat potential predators photographed by the cameras at the Boulder Creek HEF intake in Year 3 were Mule Deer, which were photographed at BDR-CAM01, BDR-CAM02, BDR-CAM03. BDR-CAM04, BDR-CAM06, and BDR-CAM08.

Figure 34. American Black Bear photographed along Boulder Creek HEF access road by BDR-CAM02 on May 14, 2020.

Figure 35. American Black Bear adult and cub photographed upslope of the Boulder Creek HEF intake by BDR-CAM06 on June 8, 2020.

Figure 36. Grey Wolf photographed by BDR-CAM08 on May 6, 2020.

Figure 37. Two Grey Wolves photographed by BDR-CAM02 travelling along the Boulder Creek HEF access road on October 20, 2020. One of these wolves had also been photographed by BDR-CAM01 13 minutes earlier. Note that this record is from prior to the start of the Mountain Goat winter/spring period.

Figure 38. Grizzly Bear photographed along Boulder Creek HEF access road by BDR-CAM02 on May 24, 2020.

Figure 39. Grizzly Bear photographed along Boulder Creek HEF access road by BDR-CAM01 on May 31, 2020.

Table 49. Potential predators of Mountain Goats photographed by remote infrared cameras near the Boulder Creek HEF intake and access road during the Year 3 monitoring period (February 25 to June 15, 2020 and November 1 to December 23, 2020). Grey shading identifies detections that occurred in the Mountain Goat winter and spring seasons (November 1 to June 15).

Species		Camera	Date	Time	Number of Individuals
Common Name	Scientific Name				
American Black Bear	*Ursus americanus*	BDR-CAM02	10-May-2020	17:07:00	1
			14-May-2020	10:50:00	1
			15-May-2020	07:56:00	1
			17-Oct-2020	12:46:00	1
		BDR-CAM06	25-May-2020	14:41:00	1
				16:20:00	1
				19:43:00	1
			26-May-2020	11:13:00	1
			06-Jun-2020	12:41:00	1
			08-Jun-2020	19:12:00	2
			15-Jun-2020	12:49:00	1
		BDR-CAM08	07-Jun-2020	17:35:00	1
Grey Wolf	*Canis lupus*	BDR-CAM01	20-Oct-2020	16:49:00	1
		BDR-CAM02	20-Oct-2020	17:02:00	2
		BDR-CAM08	06-May-2020	07:50:00	1
Grizzly Bear	*Ursus arctos*	BDR-CAM01	31-May-2020	06:36:00	1
		BDR-CAM02	24-May-2020	18:08:00	1

5. RECOMMENDATIONS

5.1. Aquatic and Riparian Habitat

5.1.1. Riparian Revegetation Assessment

Revegetation of woody vegetation was progressing well in Year 3 of the monitoring program. There was an overall increase in woody stem density and vegetation cover relative to results from Year 1 of the program. The following actions are recommended for the next monitoring year, scheduled for Year 5 (2022).

Year 5 (2022) Monitoring Recommendations:

- Continue monitoring revegetation according to the OEMP.

- Continue to survey for invasive species and plan and implement control treatments as necessary.

5.2. Water Temperature and Air Temperature

Temperature metrics recorded during Year 1 to Year 3 were not substantially different from the baseline monitoring results, however generally warmer and cooler temperatures were observed in 2018 and 2019, respectively. The warmest months on record, to date, considering both water and air temperature occurred in July/August of 2018 and 2019. Similarly, some of the coolest periods on record were observed during winter 2019 in both the water and air temperature data sets.

Year 4 (2021/22) Monitoring Recommendations:

- Continue the monitoring program in 2021 (Year 4) based on the methodologies and schedule prescribed in the Project OEMP (Harwood *et al.* 2017).
- Further review of data collected at ULL-USWQ03 suggests that one or both Tidbits had been buried for a portion of time in 2018/2019, and it does not appear as though there is a groundwater effect at this site. Accordingly, it is recommended that upstream monitoring in the Upper Lillooet River continue at this site.
- Continue to collect water temperature data in the upstream reach of Boulder Creek (BDR-USWQ2) and North Creek (NTH-USWQ1) to provide additional concurrent data sets to determine a relationship between water temperatures in the two creeks.

5.2.1. Frazil Ice

The frazil ice assessment protocol has been implemented since December 2017 and crews have responded to two alarms since this date. As stated in the OEMP, our understanding of the effect of flow on frazil ice development and effects on frazil ice on fish habitat is limited.

Year 4 (2021/22) Monitoring Recommendations:

- Monitoring is continued in each of the Upper Lillooet River and Boulder Creek diversions in accordance with the protocols used in Years 1 through 3.
- As specified in the OEMP, the effectiveness and suitability of this monitoring and management protocol should continue to be evaluated annually for the duration of the five-year monitoring period under the direction of a QP. Recommendations for refinement of the protocol and thresholds will be provided once additional data are collected and analysed.

5.3. Fish Community

5.3.1. Adult Fish Migration and Distribution

Adult Bull Trout migration and distribution monitoring was successfully implemented in Year 3 through a combination of angling surveys conducted in the diversion and downstream reaches of the

Upper Lillooet River and Boulder Creek, and in North Creek (a reference stream), and tributary bank walk spawner surveys conducted in 29.2 km Tributary and Alena Creek (both are reference streams).

Year 4 (2021) Monitoring Recommendations:

- Continue to use the same methods used in Year 3 for Years 4 and 5 of operational monitoring, as specified in the OEMP.

5.4. Wildlife Species Monitoring

5.4.1. Harlequin Ducks

No Harlequin Ducks were observed in Year 3, either during spot checks or incidentally; however, four unidentified ducks observed in the headpond incidentally in April 2020 may have been Harlequin Ducks. Harlequin Ducks were also not observed during spot checks in 2019. Harlequin Duck spot checks were conducted using zoomable surveillance cameras instead of in person using binoculars or spotting scope following the protocol (Appendix E) in both 2019 and 2020, and the headpond was drained during the May 26 spot check which may have affected Harlequin Duck use of the area. In May of 2020, the headpond was drained from May 22 – July 20, 2021 due to the forced shutdown, directed by BC Hydro; however, headpond draining is also required for sediment management, the timing of which depends on sediment accumulation (flushing occurs primarily during summer).

We therefore have the following recommendations:

- Continue annual monitoring of Harlequin Ducks for the next two years (with reporting in Year 5), in accordance with the Project's EAC (Condition #3 of the TOC) and as specified in the OEMP, to allow further evaluation of Harlequin Duck use of the immediate Project area post-construction.

- Conduct spot checks in person, using binoculars or spotting scope, from specified vantage points as per the protocols (Appendix E), unless this is not possible for safety reasons, in which case surveillance cameras can be used; note that there are two vantage points at the intake identified in the protocols that should be used when possible (Table 1 of Appendix E)).

- If possible, schedule operational maintenance of the headpond to occur outside of the Harlequin Duck breeding period (May 1- August 1) to avoid potential sensory disturbance and habitat loss; this recommendation is made with the understanding that this may not be possible in some cases (e.g., when headpond flushing is required).

5.4.2. Species at Risk & Regional Concern

Incidental wildlife observations in Year 1 have provided valuable information on the timing and locations of species at risk and of regional concern within the Project. Documenting incidental wildlife observations will continue in Years 4 and 5, as specified in the OEMP. To reduce the potential for human-wildlife conflict, it is recommended that Project personnel continue to record and share wildlife sightings with other Project personnel, especially of Grizzly Bear, Moose, and Roosevelt Elk, to raise awareness of the locations where these species are more likely to be encountered when working outdoors and driving.

5.5. Wildlife Habitat Monitoring

5.5.1. Habitat Restoration – Amphibian Habitat

Although most of the geotextile that had been covered in 2019 (following recommendations in the Year 1 report) was well covered, a small section of geotextile had become uncovered, indicating that substrate movement had occurred in the intervening two years. Thus, an additional spot check is recommended for Year 5, to be conducted in coordination with riparian revegetation monitoring, to determine whether the geotextile stays covered in the next two years. Depending on monitoring results, it will be evaluated at that time whether additional or periodic inspections or maintenance may be required.

5.5.2. Habitat Restoration – Mammal Habitat

Mammal habitat restoration compliance monitoring for Grizzly Bear, Moose, and Mule Deer indicated that for 19 of the 23 restoration monitoring sites reassessed in Year 3, vegetated screens had not yet met the required dimensions specified in the OEMP and reassessment will be required in Year 5. However, this recommendation may be modified in Year 4 depending on results of an upcoming site-specific assessment. Most of the screens identified for further monitoring had not attained the required height (5 m) but are expected to achieve this naturally, given that woody plants are growing well. However, at one site, ULH-MAMCM4B (high value Grizzly Bear habitat), vegetation growth appears to be restricted by the presence of wood chips and little progress has been documented in two years. Thus, planting is recommended in areas where wood chips are preventing the natural establishment of vegetation. Specifically, given monitoring results from Year 3, the following actions are recommended:

- All sites where vegetated screens have not yet attained the required dimensions (5 m height and width; as specified in the last column of Table 47) should be revisited in Year 5 to assess ongoing vegetated screen growth and determine if measures to enhance vegetation growth are needed (with the exception of one site that consists primarily of a scree slope where vegetation growth is naturally limited); however, this recommendation will be reconsidered in Year 4 based on an upcoming assessment of site-specific transmission line safety constraints for vegetated screen height; and
- Planting, with native species, should be conducted at ULH-MAMCM4B in areas where wood chips are preventing the natural establishment of vegetation; we recommend that the site is evaluated by a QP and that specific planting details are prescribed following such a site visit, and, unless otherwise recommended by the QP, that planting occurs in spring of 2021 to allow two seasons of growth prior to Year 5 monitoring. As directed by a QP, plants should be spaced to achieve a vegetated screen that will be at least 5 m in width and to adequately account for mortality of some plants.

5.5.3. Mitigation Effectiveness – Mountain Goats at Boulder Creek

5.5.3.1. Public Access Monitoring

Year 3 public access monitoring results indicated that the gate did not always prevent motorized traffic from entering the intake area and vehicles and snowmobiles not associated with the Project were observed along the access road during the November 1 to June 15 Mountain Goat winter/spring period.

Vehicle access during the snow-free period was observed in Year 3 either because Project personnel were at the intake (and had left the gate open) or because the gate was vandalized. The lock block placed on the upslope side of the gate in 2019 was successful in preventing passage around the gate, keeping out vehicles when the gate was closed. The signage posted at the base of the access road (in accordance with previous recommendations) did not discourage all vehicles and it was noted by Ecofish personnel accessing the intake in 2020 that that it was not highly visible; however, the vehicle that entered the area by cutting through the gate is unlikely to have been deterred from entry without enforcement measures.

Although the non-functionality of the gate across the Boulder Creek HEF access road during winter due to burial in the snow has been documented in previous monitoring years, Year 3 was the first year that snowmobiles were documented to pass over the gate during this sensitive period. In previous monitoring years, gate inadequacies when buried in snow were not identified as an issue because no incidents of the public passing the gate at such times were documented and snowmobile access to this area was considered challenging due to the distance of travel that would be required along an ungroomed road.

Given that snowmobile use of the access road beyond the gate during the sensitive winter/spring period was documented in Year 3 and that two vehicles came through the access gate during Year 3 monitoring, we make the following recommendations:

- Ensure that Project personnel close the gate behind them when entering the intake area (not just when leaving the area, and even when only planning to be at the intake for a short period of time) so that the gate is continually closed to the public during the sensitive winter/spring period; this requirement should be clearly and unambiguously stated in the internal email communication instructing closure of the gate on November 1 and that understanding of this requirement is confirmed;
- Consider increasing camera surveillance along the access road, potentially near the gate where it may be possible to record vehicle license plates or in other locations along the access road, and reporting incidences of vandalism and unauthorized use of the road;
- Improve signage to inform the public of the closure of the access road between November 1 and June 15 by installing two large and highly visible signs, one at the base of the access road and one at the gate. The sign at the base of the access road should indicate that there is no

entry by any kind of motorized transport permitted during the November 1 to June 15 period and that there is a locked gate ahead. In addition, both signs should:

- Be visible during both summer and winter, including in high snow years;
- Be large enough to be highly visible and contain all of the needed information (e.g., minimum 1 m^2 in size and potentially larger to accommodate all text);
- Have text in large, highly visible font (bright colours, large font);
- State that the entry of the area is prohibited for all forms of motorized modes of transport between November 1 and June 15 due to the presence of highly sensitive wildlife habitat, specifically stating that this includes snowmobiles and ATVs; and
- State that the area is under surveillance.

- Explore options for modifying the gate so that it is more likely to be effective in preventing snowmobile access when snow buries the current gate. The gate should be made taller, so that it extends above the snow line during winter, in a manner that will not cause a safety risk to staff member and members of the public. A potential idea is to:
    - Attach tall, vertical, brightly coloured pilons to both ends of the gate that extend above the height of snow during high snow winters (clearly indicating the locations of the gate posts) and connect these pilons with a high visibility, lightweight, and slightly flexible plastic rod; this rod would be highly visible above the snow line, yet would bend or break under force in the event that it became buried in snow in an extreme snow year and was run into by the runners or body of a snowmobile (thus it would be a deterrent for snowmobilers not willing to damage property but would not create a potential safety issue).
- Continue monitoring for at least another year (with additional monitoring requirements evaluated after Year 4) to evaluate if use of this area by snowmobiles continues, if other measures implemented to prevent access are effective, and if problems with the gate during the snow-free period continue.

5.5.3.2. Predator Monitoring

Grey Wolves, which are considered main predators of Mountain Goats, were detected for the first time in the Boulder Creek HEF intake area in Year 2 of post-construction monitoring and were also detected in Year 3. This may indicate that Grey Wolves have discovered the access road and may be beginning to make greater use of the intake area, which could lead to their increased presence within the Mountain Goat UWR in winter. Although Year 3 wolf observations during the winter/spring period were not on the road, wolves were travelling along the road in March in Year 2 and in October of Year 3, which could suggest that they are gaining familiarity with it. Cougars are another main predator of Mountain Goats, but they have been detected in the intake area only in Year 2 to date.

We recommend that predator monitoring via wildlife cameras is continued for at least another year (with additional monitoring requirements evaluated after Year 4) to allow better evaluation of the potential for an increase in main predators of Mountain Goats in the intake area and along the access road. This recommendation is made for four reasons:

- Based on monitoring results to date, there is some indication that Grey Wolf use of the intake area has increased since Project construction;
- The typically low frequency of predator detections increases the need for data to allow comparison among periods; and
- Some cameras positioned along the survey transects have been non-functional at times during the winter survey periods creating gaps in the data record.

Results from an additional year of data collection would help to evaluate if use of the area by predators of Mountain Goats (especially Grey Wolves) is increasing or if monitoring is simply documenting periodic and variable use of an area by predators potentially owing to their large home range sizes and changeable environmental factors.

6. CLOSURE

The OEMP outlines the operational monitoring frequency and duration for each monitoring component. The monitoring objectives for Year 3 were achieved. Changes to the monitoring programs being conducted under the Project's OEMP were recommended following the results of the Year 2 report. These considerations were submitted in a separate submission for review and approval by regulatory agencies.

REFERENCES

Barker, S. and Staven, W. 2017. Final Revegetation Assessment for the Upper Lillooet Hydro Project. Consultant's report prepared for Upper Lillooet River Power LP and Boulder Creek Power LP. Vancouver, BC.

Barker, 2019. Memorandum prepared for Tanya Katamay-Smith of for Upper Lillooet River Power Limited Partnership and Boulder Creek Limited Partnership, prepared March 26, 2019 Re: Reforestation summary of October 2018 tree planting for civil works sites at the Upper Lillooet Hydro Project.

Barker, S. 2020. Upper Lillooet Hydro Project: Survival Surveys Report - Civil Works Sites. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Limited Partnership, Vancouver, BC.

Barrett, J. 2015. Further Exemption from General Wildlife Measures for Ungulate Winter Range Related to the Boulder Creek Hydroelectric Facility (78700-35/06 UWR). Letter to J. Mancinelli, Boulder Creek Power Limited Partnership from S. Barrett, Ministry of Forests, Lands and Natural Resource Operations. November 13, 2013.

Berardinucci, J. 2013b. Exemption from General Wildlife Measures for Ungulate Winter Range and Wildlife Habitat Areas related to the Upper Lillooet Hydro Project's Transmission Line. Letter to J. Mancinelli, Upper Lillooet River Power Limited Partnership from J. Berardinucci, Ministry of Forests, Lands and Natural Resource Operations. August 7, 2013.

Calkins, J.D. 1993. Major river ice types and covers. Chap. In Environmental Aspects of River Ice. p. 4-11. National Hydrology Research Institute, Environment Canada, Saskatoon, Saskatchewan, Canada: Prowse, T.D. and Gridley, N.C. editors.

Coleman, M.A. and K.D. Fausch. 2007. Cold summer temperature limits recruitment of age-0 cutthroat trout in high-elevation Colorado streams. Transactions of the American Fisheries Society 136:1231–1244.

CRT-ebc. 2016. Upper Lillooet Hydro Project Master Reclamation Work Plan. WP-CE-097. October 17, 2016.

DFO and MELP (Department of Fisheries and Oceans and Ministry of Environment, Lands and Parks. 1998. Riparian Revegetation. Available online at: http://www.dfo-mpo.gc.ca/Library/315523.pdf. Accessed on February 22, 2019.

DFO (Department of Fisheries and Oceans Canada). 2016. Review of Long Term Monitoring results from small hydro projects to Verify Impacts of Instream Flow Diversion on Fish and Fish Habitat. DFO Can. Sci. Advis. Sec. Sci. Resp. 2016/048.

EAO (BC Environmental Assessment Office). 2013. Upper Lillooet Hydro Project Environmental Assessment Certificate #E13-01. January 8, 2013.

Faulkner, S.G., A. Yeomans-Routledge, and A. Lewis. 2011. Upper Lillooet Hydro Project. Environmental Background – Fish Habitat. Report 3: Fish Habitat and Fish Community V.3. Consultant's report prepared by Ecofish Research Ltd. for Creek Power Inc.

Forest Renewal BC. 2001. Juvenile Quality Spacing Quality Inspection. Available at: http://www.for.gov.bc.ca/isb/forms/lib/fs251.pdf. Accessed on November 16, 2016.

Harwood, A., S. Faulkner, A. Yeomans-Routledge, K. Ganshorn, I. Mencke, M. Sloan, and D. Lacroix. 2013b. Upper Lillooet River and Transmission Line Hydroelectric Facilities – Aquatic Baseline Report. Consultant's report prepared by Ecofish Research Ltd. July 17, 2013.

Harwood, A., S. Faulkner, K. Ganshorn, D. Lacroix, A. Newbury, H. Regehr, X. Yu, D. West, A. Lewis, S. Barker and A. Litz. 2017. Upper Lillooet Hydro Project: Operational Environmental Monitoring Plan. Consultant's report prepared for the Upper Lillooet River Power Limited Partnership and the Boulder Creek Power Limited Partnership. March 17, 2017.

Harwood, A., S. Faulkner, K. Ganshorn, D. Lacroix, A. Newbury, H. Regehr, X. Yu, D. West, A. Lewis, S. Barker and A. Litz. 2021. Upper Lillooet Hydro Project: Operational Environmental Monitoring Plan. Consultant's report prepared for the Upper Lillooet River Power Limited Partnership and the Boulder Creek Power Limited Partnership. April 28, 2021.

Hatfield, T., A.F. Lewis, and S. Babakaiff. 2007. Guidelines for the collection and analysis of fish and fish habitat data for the purpose of assessing impacts from small hydropower projects in British Columbia. Prepared by Solander Ecological Research Ltd. and Ecofish Research Ltd. for the BC Ministry of Environment, Surrey BC. Available online at: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/best-management-practices/guidelinesifrv5_2.pdf. Accessed on April 14, 2020.

Hedberg (Hedberg and Associates Ltd.). 2011. Forest Resource Impact Assessment Upper Lillooet Hydro Project. Consultant's report prepared by Ecofish Research Ltd. for Creek Power Inc.

Hicks, T., and A. Sartori. 2017. Upper Lillooet Hydro Project: Final Update on the Status of Reclamation Efforts and Outstanding Environmental Monitoring Issues – Condition 18 of the ULRHEF LTCD and Condition 17 of the BDRHEF LTCD. October 27, 2017.

Innergex. 2013. Construction Environmental Management Plan for the Upper Lillooet Hydro Project. Consultant's report prepared for the Upper Lillooet River Power Limited Partnership, Boulder Creek Power Limited Partnership, and the North Creek Hydro Power Limited Partnership.

Johnston, C. 2020 Upper Lillooet Hydro Project: Revegetation Assessment Report for the Operational Environmental Monitoring Plan (OEMP), Year 3 - 2020 Monitoring Year. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Limited Partnership, Vancouver, BC.

Lacroix, D., A. Newbury, M. Schulz, and M. Sloan. 2011a. Upper Lillooet Hydro Project: Wildlife Environmental Study and Assessment: Breeding Birds, Harlequin Ducks, and Raptor/Heron Nests. Consultant's report prepared by Ecofish Research Ltd. for Creek Power Ltd.

Lacroix, D., A. Newbury, M. Schulz, T. Jensma and M. Sloan. 2011b. Upper Lillooet Hydro Project: Wildlife Environmental Study and Assessment: Amphibians, Reptiles and Invertebrates, Version 1 Consultant's report prepared by Ecofish Research Ltd.

Lacroix, D., A. Newbury, M. Schulz, and M. Sloan. 2011c. Upper Lillooet Hydro Project: Wildlife Environmental Study and Assessment: Northern Goshawk (subspecies *laingi)* and Peregrine Falcon (subspecies *anatum*). Consultant's report prepared by Ecofish Research Ltd. for Creek Power Inc.

Lacroix, D., B. Schroeder and A. Newbury. 2011d. Upper Lillooet Hydro Project: Wildlife Environmental Study and Assessment: Spotted Owl and Western Screech-Owl. Version 2. Consultant's report prepared by Ecofish Research Ltd.

Leigh-Spencer, S., H. Bears, D. Lacroix, A. Newbury, and M. Schulz. 2012. Upper Lillooet Hydro Project: Wildlife Environmental Assessment - Mammals. Consultant's report prepared by Ecofish Research Ltd., Ecological Consulting Ltd., and Zoetica Wildlife Research Services for Creek Power Inc.

Leigh-Spencer, S., D. Lacroix, L. Ballin, and A. Newbury. 2013. Grizzly Bear Suitable Foraging Habitat Verification for Areas Overlapping the Upper Lillooet Hydro Project Infrastructure and Ancillary Components. Consultant's memorandum prepared for Upper Lillooet River Power Limited Partnership by Ecologic Consulting Inc. and Ecofish Research Ltd. August 13, 2013.

Lewis, A., D. Urban, S. Buchanan, M. Schulz, S. Faulkner, K. Ganshorn, K. Healey, A. Harwood, M. Sloan, T. Jensma, and G. Stewart. 2012. Upper Lillooet Hydro Project. Aquatic Environmental Assessment Final Report. Consultant's report prepared by Ecofish Research Ltd. January 18, 2012.

Lewis, F.J.A., A.J. Harwood, C. Zyla, K.D. Ganshorn, and T. Hatfield. 2013. Long term Aquatic Monitoring Protocols for New and Upgraded Hydroelectric Projects. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/166. ix + 88p. Available online at: https://waves-vagues.dfo-mpo.gc.ca/Library/40622617.pdf Accessed on April 14, 2020.

Lewis, F.J.A., A.J. Harwood, C. Zyla, K.D. Ganshorn, and T. Hatfield. 2013a. Long term Aquatic Monitoring Protocols for New and Upgraded Hydroelectric Projects. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/166. ix + 88p. Available online at: http://www.dfo-mpo.gc.ca/Csas-sccs/publications/resdocs-docrech/2012/2012_166-eng.pdf. Accessed on June 20, 2013.

MAL (BC Ministry of Agriculture and Lands). 2008. Sea-to-Sky LRMP (Land and Resource Management Plan). April 2008. Available online at: http://archive.ilmb.gov.bc.ca/slrp/lrmp/surrey/s2s/docs/S2S_LRMP_Final/S2SLRMP_Final_April2008.pdf. Accessed on January 3, 2013.

McKeachie, I., L. Leblond, J. Pelletier, S. Munneke, and J. Drapeau. 2016. Upper Lillooet Hydro Project Master Reclamation Work Plan. WP-CE-097. Consultant's Report prepared by CRT-ebc for Innergex Renewable Energy Inc. October 17, 2016.

Meier, W., C. Bonjour, A. Wüest and P. Reichert. 2003. Modeling the effect of water diversion on the temperature of mountain streams. Journal of Environmental Engineering, 129: 755-764.

MFLNRO (BC Ministry of Forests, Lands and Natural Resources Operations). 2014. Stand Development Monitoring Protocol. Field and Office Procedures for Stand Development Monitoring Surveys. SDM Technical committee. March 2014. Available online at: https://www.for.gov.bc.ca/ftp/hfp/external/!publish/FREP%20-%20Website/Indicators%20and%20Protocols/FREP%20SDM%20Protocol_Mar2014.pdf. Accessed on February 21, 2019.

MFLNRO (BC Ministry of Forests, Lands and Natural Resources Operations). 2015. Silviculture Survey Procedures Manual – Regen Delay, Stocking and Free Growing Surveys – plus Alternative Survey Methodologies. Resources Practices Branch. April 1, 2015. Available online at: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/silviculture/silviculture-surveys/silviculture_survey_procedures_manual.pdf. Accessed on February 21, 2019.

MOE (B.C. Ministry of Environment). 2019. Approved Water Quality Guidelines. Available online at: http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-guidelines/approved-water-quality-guidelines. Accessed on November 30, 2018.

Monnot, L., J. B. Dunham, T. Hoem, and P. Koetsier. 2008. Influences of Body Size and Environmental Factors on Autumn Downstream Migration of Bull Trout in the Boise River, Idaho. North American Journal of Fisheries Management 28:231–240, 2008.

MWLAP. 2004. Accounts and Measures for Managing Identified Wildlife. BC Ministry of Water, Land and Air Protection. Available online at: http://www.env.gov.bc.ca/wld/frpa/iwms/accounts.html Accessed on August 5, 2012.

Newbury, A., V. Woodruff, D. Lacroix. 2018. Boulder Creek HEF Mitigation Effectiveness Monitoring for Mountain Goats – Revision to Monitoring Methodology. Consultant's memorandum prepared for the Boulder Creek Power Limited Partnership by Ecofish Research Ltd. December 10, 2018.

NHC (Northwest Hydraulic Consultants). 2011. Upper Lillooet Hydro Project Overview-Level Geomorphological Assessment. Consultant's report prepared by Northwest Hydraulic Consultants Ltd. for Creek Power Inc. November 24, 2011.

Oliver, G.G. and L.E. Fidler. 2001. Towards a water quality guideline for temperature in the Province of British Columbia. Prepared for Ministry of Environment, Lands and Parks, Water Management Branch, Water Quality Section, Victoria, B.C. Prepared by Aspen Applied Sciences Ltd., Cranbrook, B.C., 53 pp + appnds. Available online at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/temptech/index.html. Accessed on May 23, 2012.

Regehr, H., D. Lacroix, A. Newbury, and S. Leigh-Spencer. 2014. Environmental Protection Plan: Human-bear conflict management plan. Consultant's Environmental Protection Plan prepared for Upper Lillooet Hydro Project by Ecofish Research Ltd.

Regehr, H., D. Lacroix, A. Newbury, and L. Ballin. 2016. Upper Lillooet Hydro Project: Wildlife Baseline Monitoring Report V2. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership by Ecofish Research Ltd. July 14, 2016.

Regehr, H. A. Newbury, N. Swain, A. Yeomans-Routledge, S. Johnson, S. Sharron, S. Whyte, V. Woodruff, M. Dyck, T. Jensma, S. Faulkner, K. Ganshorn, T. Hicks, and D. Lacroix. 2019. Upper Lillooet Hydro Project Terrestrial and Wildlife OEM: Year 1. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership by Ecofish Research Ltd., April 25, 2019.

RISC. 1998. Guidelines for Interpreting Water Quality Data. Field Test Edition. Prepared by the BC Ministry of Environment, Lands and Parks Water Quality Branch. Available online at: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/nr-laws-policy/risc/guidlines_for_interpreting_water_quality_data.pdf. Accessed on February 12, 2019.

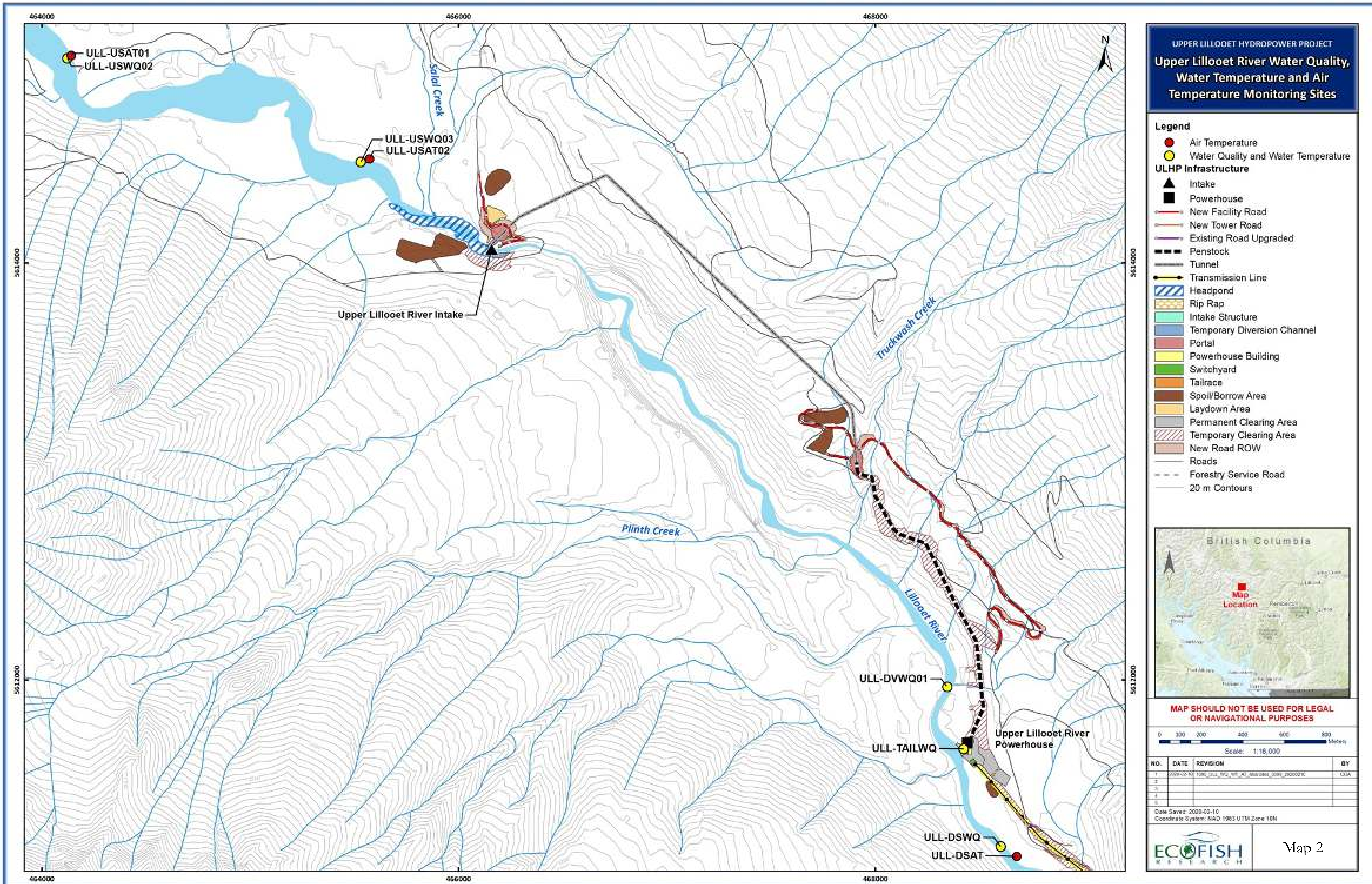
Shackleton, D. M. 1999. The Hoofed Mammals of British Columbia. Volume 3: The Mammals of British Columbia. Royal British Columbia Museum, Victoria, and UBC Press, Vancouver. 268 pp.

Woodruff, V., A. Newbury, and D. Lacroix. 2017. Upper Lillooet Hydro Project – Confirmation of Reclamation and Revegetation Works at Designated Riparian Sites. Consultant's Memo prepared by Ecofish Research Ltd. July 6, 2017.

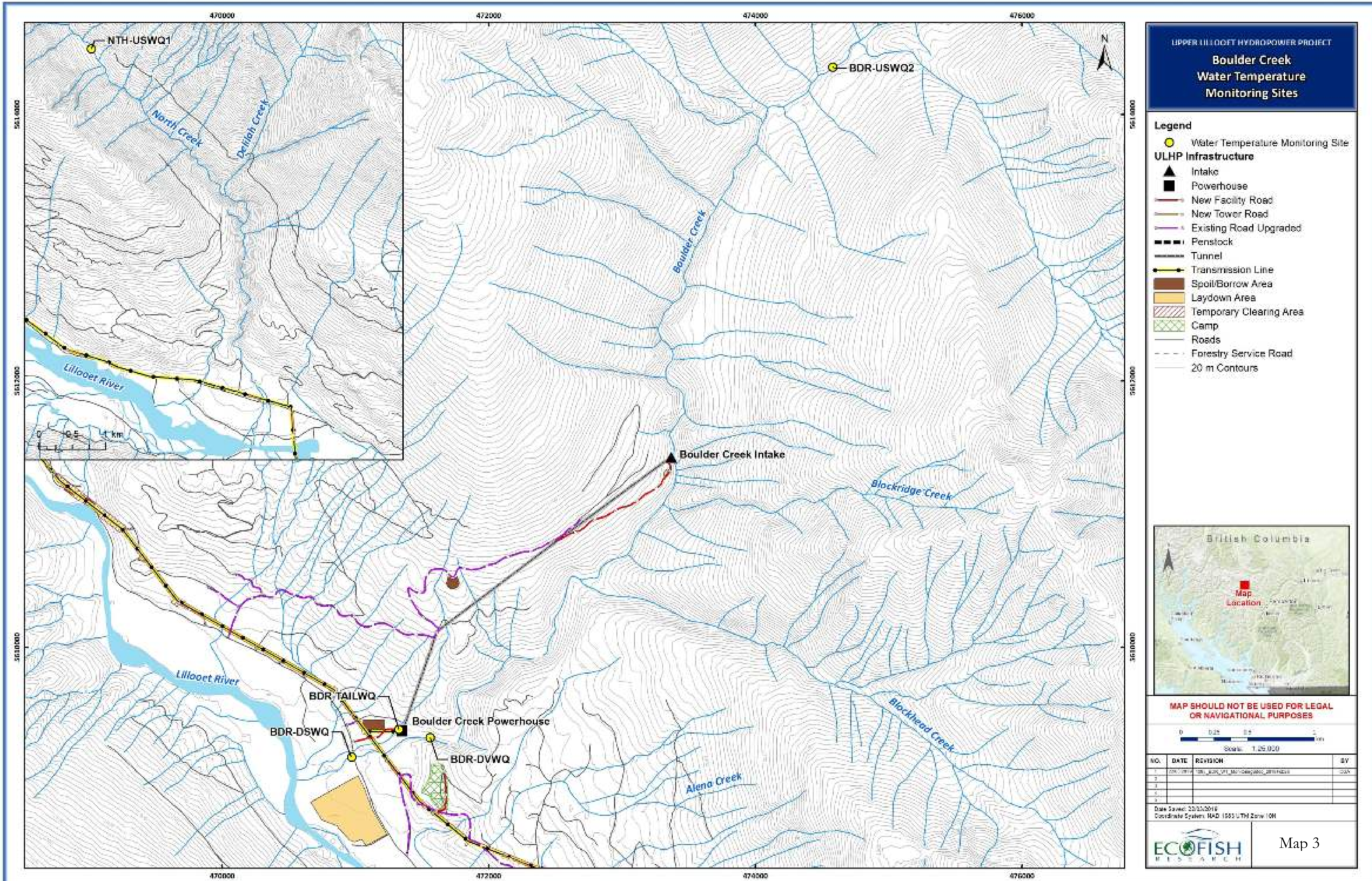
Personal Communications

T. Katamay-Smith. 2020. Internal email communication with ULHP operators regarding closing of Boulder Creek HEF intake gate, sent on November 1, 2020.

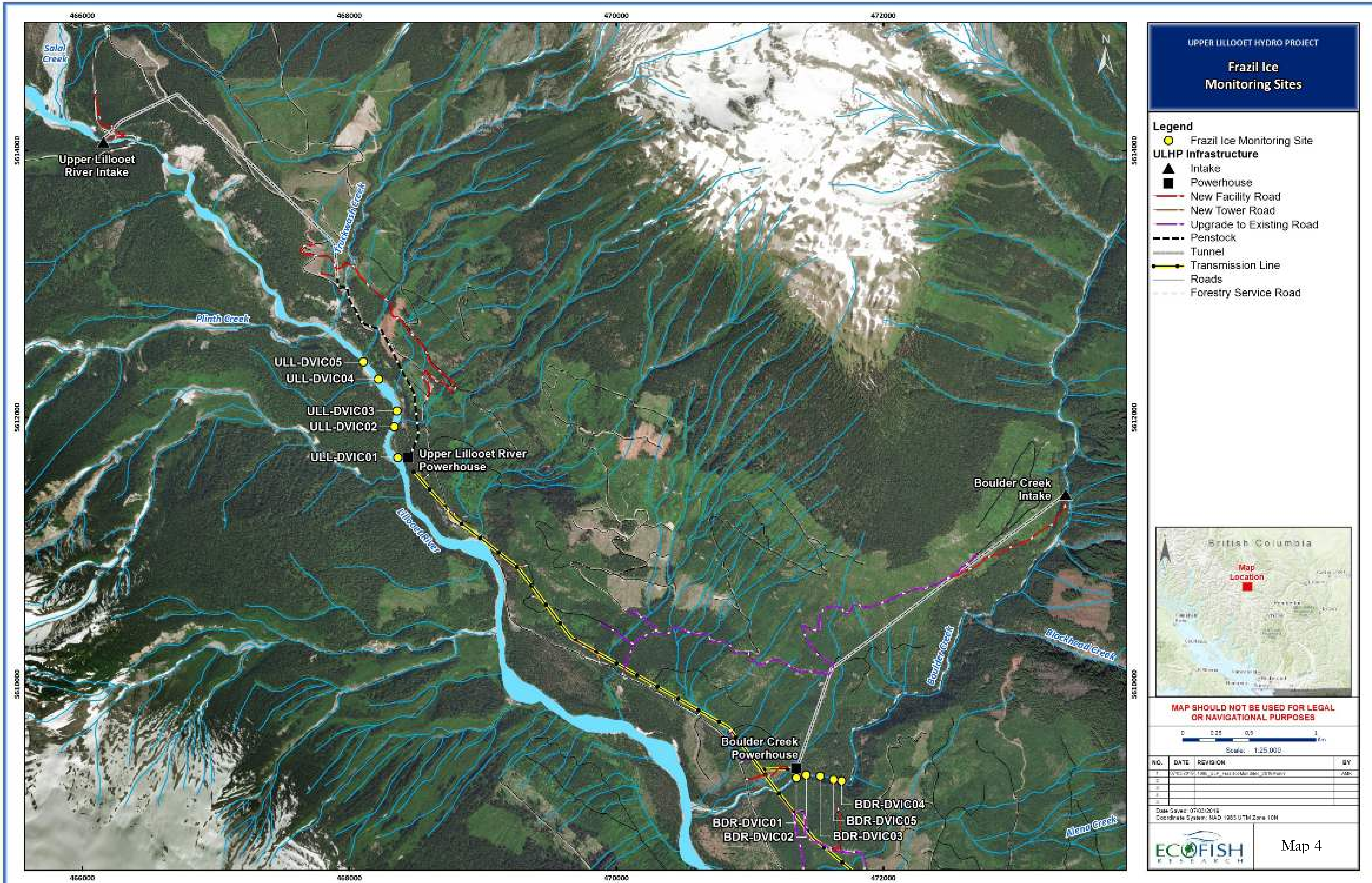
PROJECT MAPS



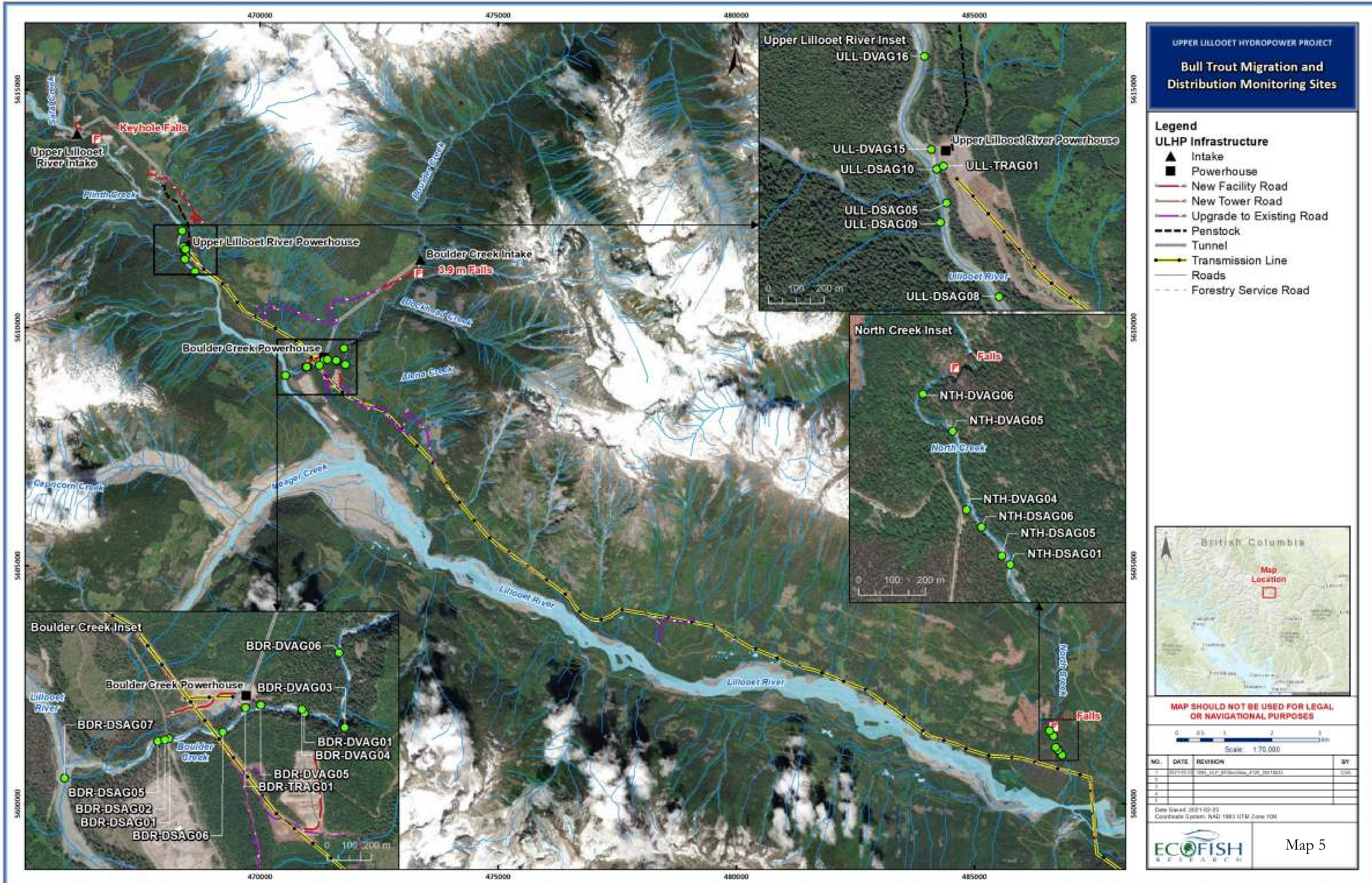
Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\WaterQuality\1095_ULL_WQ_WT_AT_MonSites_3599_20200210.mxd



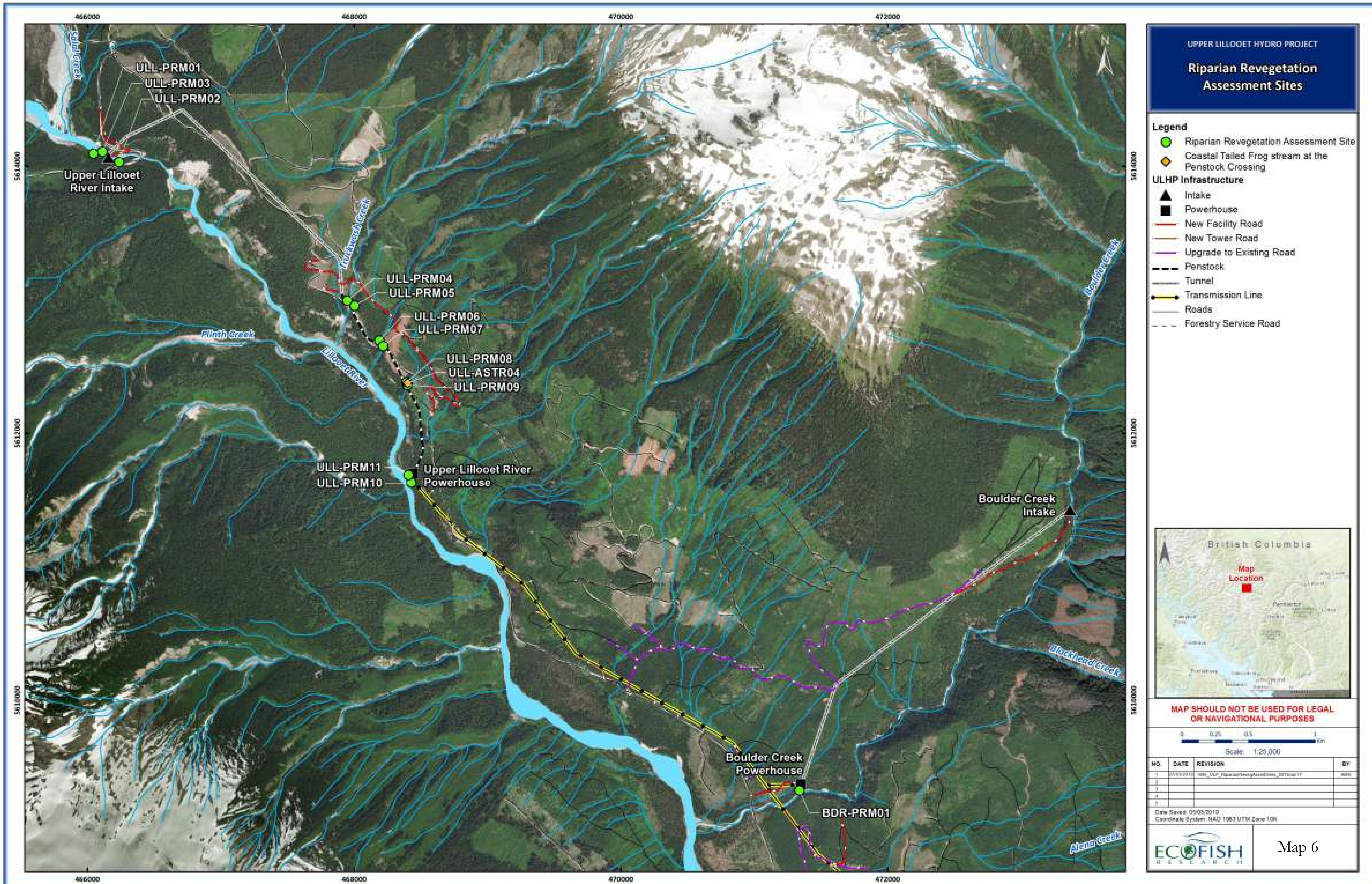
Path: M:\Projects Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\WaterQuality\1095_BDR_WT_MonitoringSites_2019Feb20.mxd



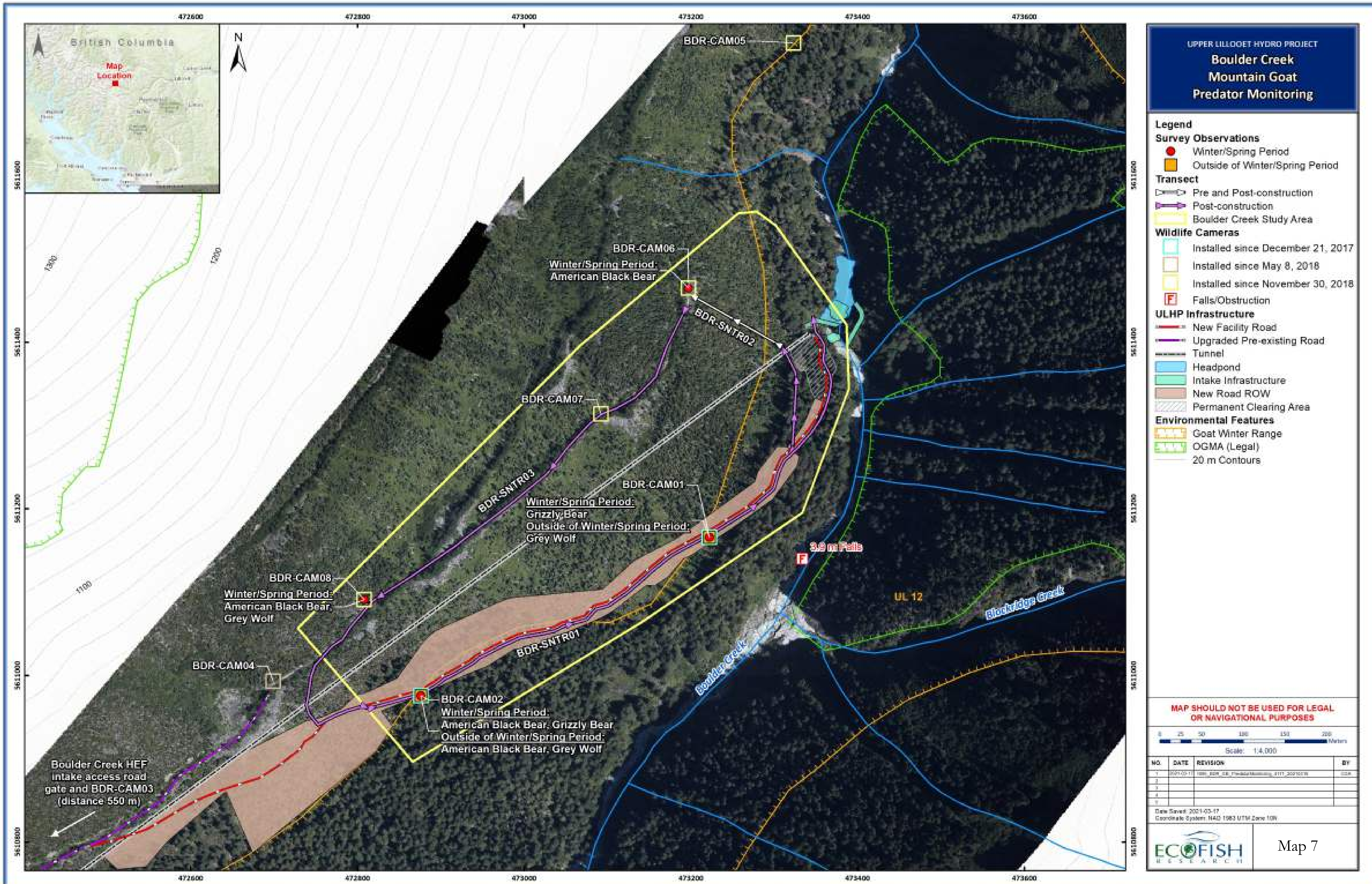
Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Fisheries\1095_ULP_FrazilIceMonSites_2019Mar07.mxd



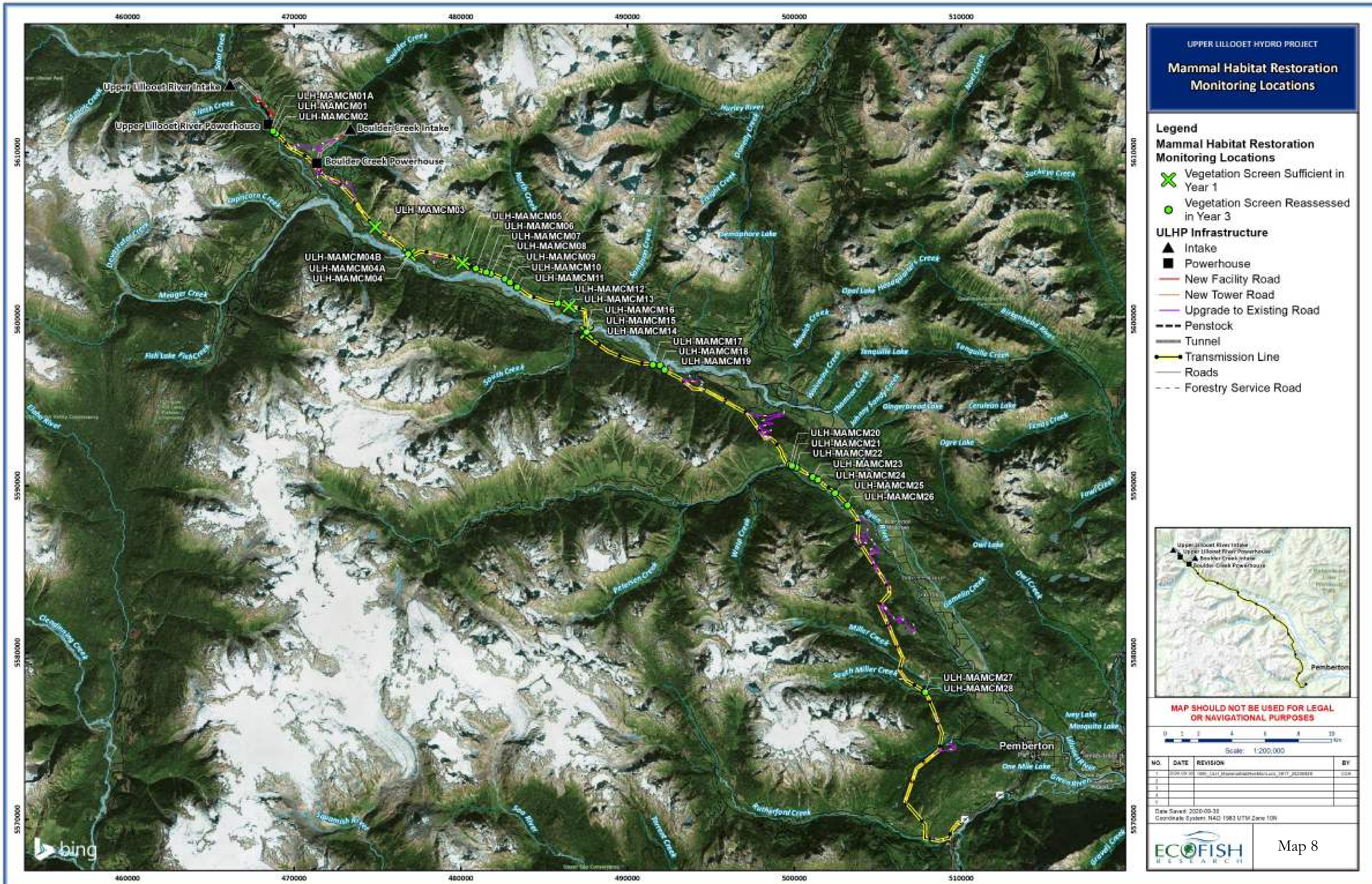
Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Fisheries\1095_ULP_BTMonSites_4129_20210225.mxd



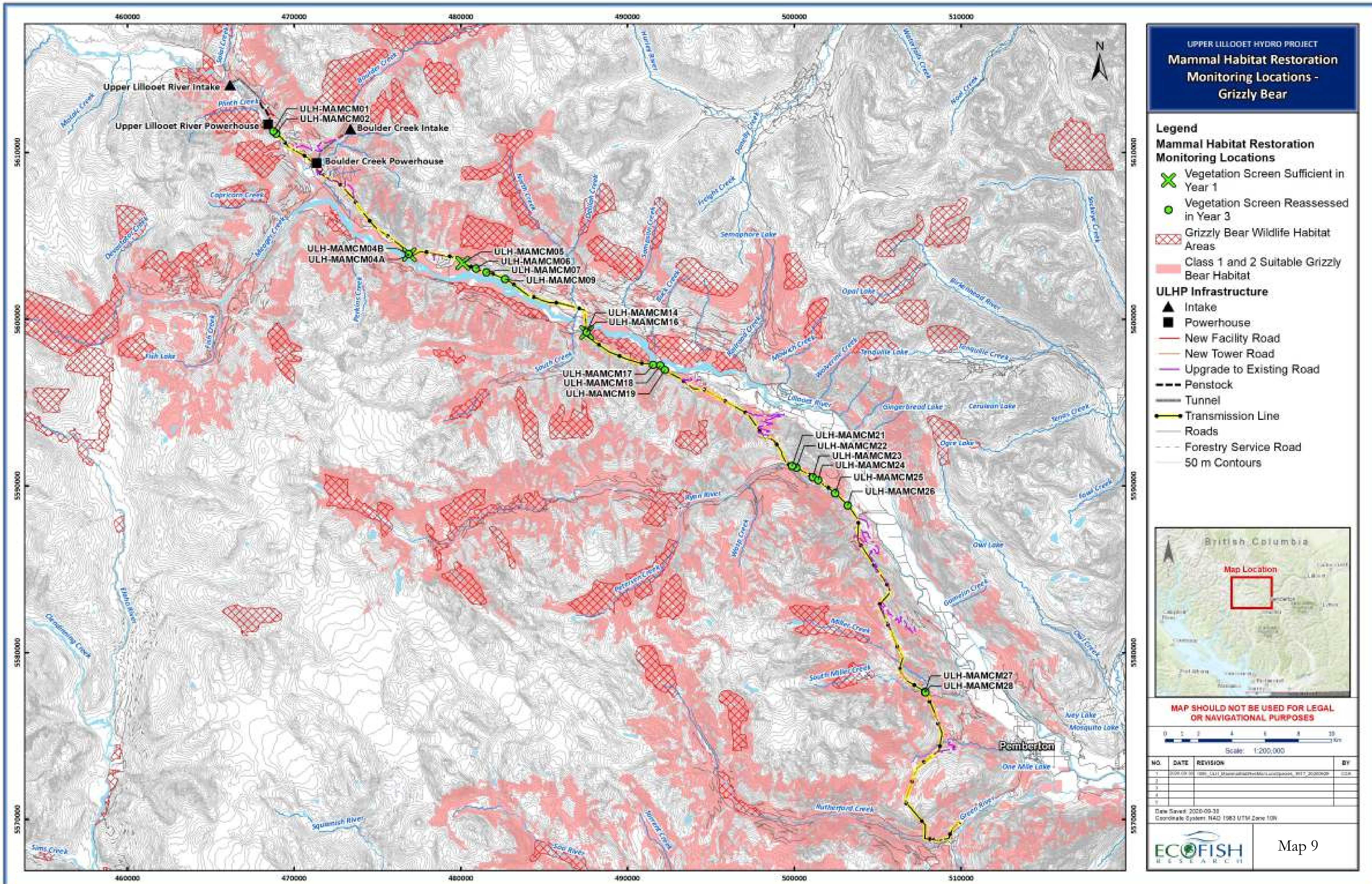
Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Riparian\1095_ULP_RiparianRevegAssmtSites_2019Jan17.mxd



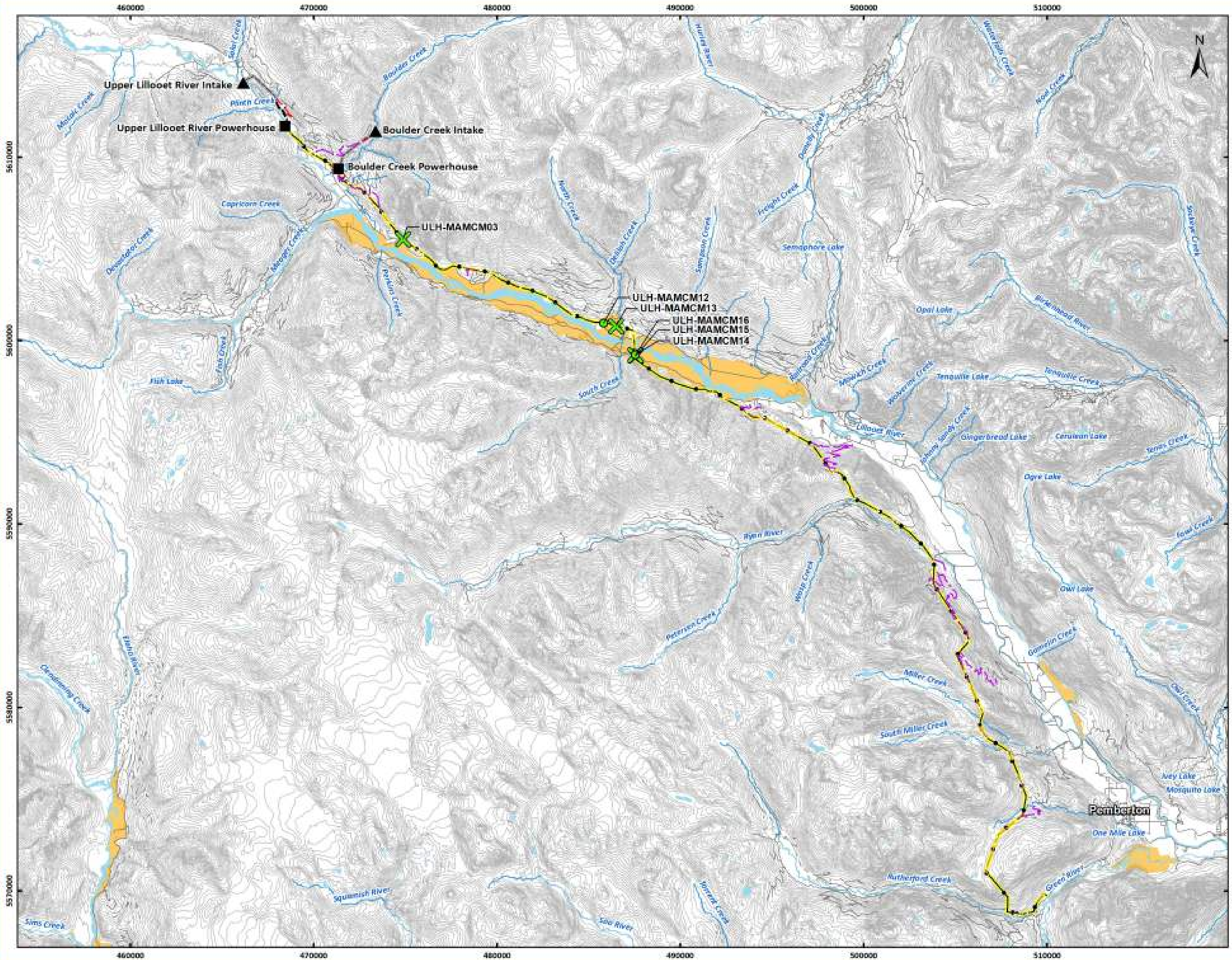
Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Wildlife\9_OEMP\1095_BDR_GB_PredatorMonitoring_4171_20210316.mxd



Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Wildlife\1095_ULH_MammalHabResMonLocs_3917_20200929.mxd



Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Wildlife\1095_ULH_MammalHabResMonLocsSpecies_3917_20200929.mxd



Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Wildlife\1095_ULH_MammalHabResMonLocsSpecies_3917_20200929.mxd

UPPER LILLOOET HYDRO PROJECT

Mammal Habitat Restoration Monitoring Locations - Moose

Legend

Mammal Habitat Restoration Monitoring Locations

- Vegetation Screen Sufficient in Year 1
- Vegetation Screen Reassessed in Year 3
- Moose Winter Range

ULHP Infrastructure

- Intake
- Powerhouse
- New Facility Road
- New Tower Road
- Upgrade to Existing Road
- Penstock
- Tunnel
- Transmission Line
- Roads
- Forestry Service Road
- 50 m Contours

MAP SHOULD NOT BE USED FOR LEGAL OR NAVIGATIONAL PURPOSES

0 1 2 4 6 8 10 Km

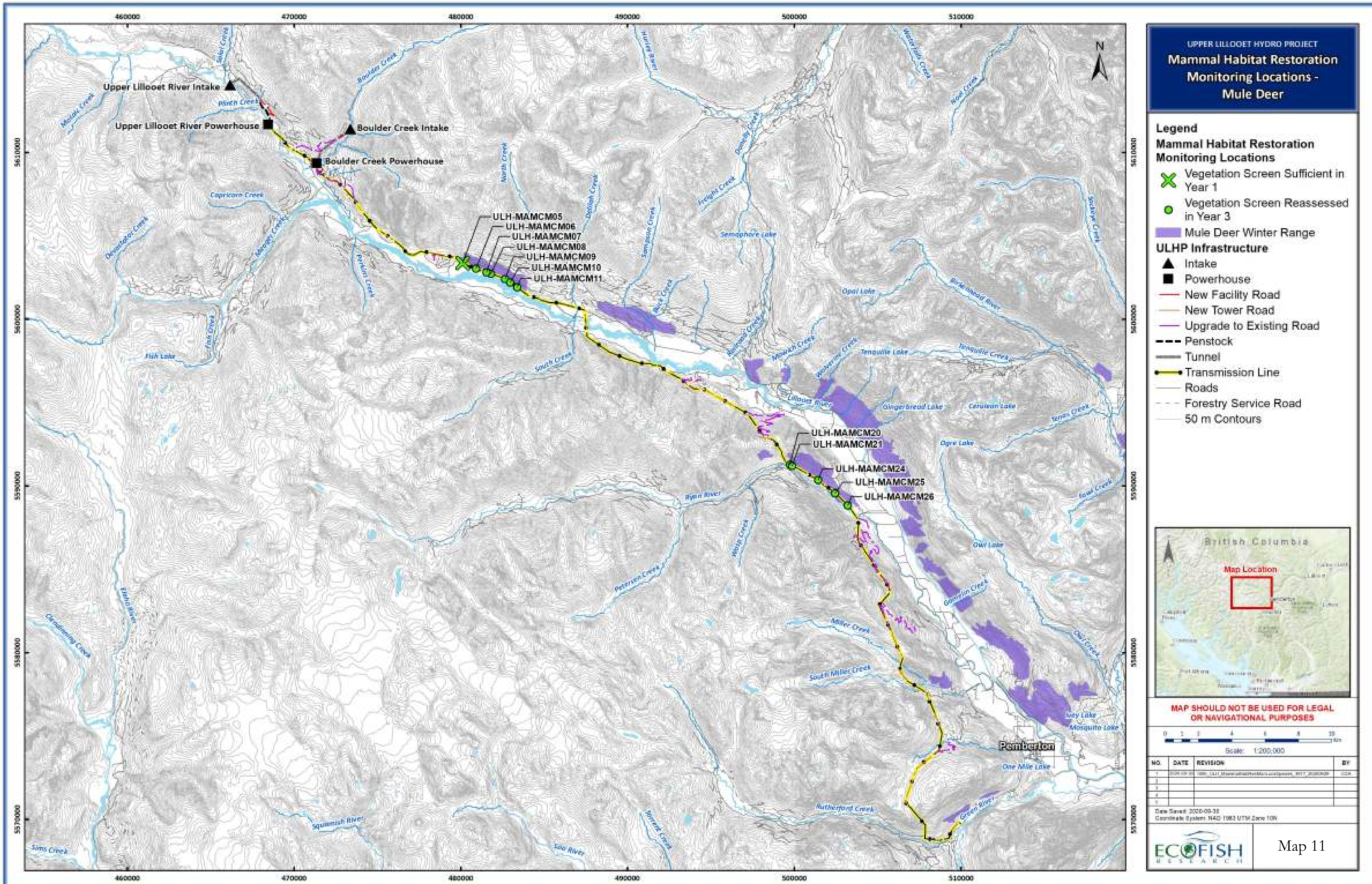
Scale: 1:200,000

NO.	DATE	REVISION	BY
1	2020-09-30	1095_ULH_MammalHabResMonLocsSpecies_3917_20200929	[illegible]
2			
3			
4			
5			

Date Saved: 2020-09-30
Coordinate System: NAD 1983 UTM Zone 10N

ECOFISH RESEARCH

Map 10



Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Wildlife\1095_ULH_MammalHabResMonLocsSpecies_3917_20200929.mxd

Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Wildlife\HarlequinDuck\1095_ULP_HADU_SpotCheckSurveys2020_4173_20210316.mxd

APPENDICES

Appendix A. Alena Creek Fish Habitat Enhancement Project Year 4 Monitoring Report

Alena Creek Fish Habitat Enhancement Project

Year 4 Monitoring Report

Prepared for:

Upper Lillooet River Power Limited Partnership
888 Dunsmuir Street, Suite 1100
Vancouver, BC V6C 3K4

April 28, 2021

Prepared by:

Ecofish Research Ltd.

ECOFISH RESEARCH

Published by Ecofish Research Ltd., 600 Comox Rd., Courtenay, B.C., V9N 3P6

For inquiries contact: Technical Lead documentcontrol@ecofishresearch.com 250-334-3042

Citation:

Thornton, M., T. Jensma, V. Dimma, D. West, S. Faulkner, K. Ganshorn, D. Stanyer, and H. Regehr, 2021. Alena Creek Fish Habitat Enhancement Project: Year 4 Monitoring Report. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., April 28, 2021.

Certification: *stamped version on file.*

Senior Reviewer:

Sean Faulkner, M.Sc., R.P.Bio. No. 2242

Fisheries Scientist/Project Manager

Technical Leads:

Kevin Ganshorn, M.Sc., R.P.Bio. No. 2448

Biologist/Project Manager

David West, M.Sc., P.Eng. No. 41242

Water Resource Engineer/Technical Lead

Sean Faulkner, M.Sc., R.P.Bio. No. 2242

Fisheries Scientist/Project Manager

Disclaimer:

This report was prepared by Ecofish Research Ltd. for the account of Upper Lillooet River Power Limited Partnership. The material in it reflects the best judgement of Ecofish Research Ltd. in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Ecofish Research Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions, based on this report. This numbered report is a controlled document. Any reproductions of this report are uncontrolled and may not be the most recent revision.

EXECUTIVE SUMMARY

This report provides the Year 4 (2020) results of the long-term monitoring program implemented to evaluate the effectiveness of the Fish Habitat Enhancement Project (FHEP) constructed on Alena Creek (also known as Leanna Creek) as per the *Fisheries Act* Authorization (09-HPAC-PA2-00303) issued for the Upper Lillooet Hydro Project (the Project). The FHEP was designed to offset the footprint and operational habitat losses incurred by the Project. Alena Creek is a tributary to the Upper Lillooet River located approximately 4.1 km downstream of the confluence of Boulder Creek with the Upper Lillooet River.

Historical fish and fish habitat data from Alena Creek and long-term monitoring requirements for the FHEP were originally described in the Alena Creek Long-Term Monitoring Program (Harwood *et al.* 2013). Long-term monitoring requirements were subsequently revised and integrated into the Project's Operational Environmental Monitoring Plan (OEMP) (Harwood *et al.* 2017). Baseline data were collected for Alena Creek in 2013 and 2014. Post-construction (i.e., post enhancement) monitoring started in fall of 2016 and has continued through 2017 (Year 1), 2018 (Year 2), 2019 (Year 3), and 2020 (Year 4). This report presents the results of Year 4 monitoring.

Fish Habitat

A stability assessment was conducted to monitor the stability and functionality of each of the FHEP habitat features (riffles and woody debris) and ensure that any remedial action required to maintain their effectiveness is promptly identified and implemented. Photo-points were established during the as-built survey in 2016 at a total of eight survey transects and a panorama of photos was taken each monitoring year to evaluate changes in habitat conditions over time. Qualitative observations were also made along the entire FHEP enhanced reaches.

Excessive erosion that reduces the quality of the constructed habitat has not occurred to date. The channel adjustments that occurred after a peak flow event in November 2016 were modest and have largely stabilized due to vegetation establishment and natural sorting of sediment. However, in Year 3 (2019), multiple locations were identified where remediation was recommended, and instream repairs were conducted during the least risk timing window by a crew of four on August 6, 2020. Repairs were done by hand using gravel, cobble, small boulder, and large wood pieces found on site to improve functionality and limit erosion through bank revetments, flow deflector installation, riffle repairs, and gravel redistribution.

A beaver dam complex located immediately upstream of Reach 3 was causing partial flow bypass and formation of newly cut channels that increased fine sediment deposition within the reach; therefore, the dam height was lowered to prevent further channel erosion. No new beaver activity was observed above Reach 3 in 2020, and the dam was considered inactive in 2020. In November 2020, two newly constructed beaver dams in the lower end of Reach 3 created moderate backwatering in ALE-XS5, ALE-X06, and ALE-XS7. Beavers were trapped within the Alena Creek enhancement area and the dams found within the enhanced spawning channels were removed in the fall of 2020 by a licensed

trapper from EBB Environmental Consulting Inc. with the objective of ensuring salmon spawner access and spawning riffle functionality.

In Reach 1, a log jam just upstream of ALE-XS1 has formed which should be monitored to ensure it does not cause backwatering of upstream riffles and associated fine sediment deposition. Associated bank erosion issues were partially addressed by placing cobble along the head of a cutoff channel that has formed and largely stabilized.

Recommendations for Year 5 included continued management of beaver activity, continuing photos at transects and throughout the constructed channels, and identification of erosion issues.

Fish Community

The adult fish community in Alena Creek was assessed by bank walk spawner surveys focused on Coho Salmon (*Oncorhynchus kisutch*), the dominant species within Alena Creek, completed over three surveys between November and December 2020. Coho Salmon were observed spawning and holding in the enhanced habitat in Alena Creek demonstrating their continued use. Within enhanced and unenhanced areas, a peak of 218 live Coho Salmon were observed on November 19, 2020, which was the highest annual peak observed during monitoring to date (previous peak counts ranged from 111 to 192, in 2011 and 2016 respectively). Annual peak counts occurred between November 5 and December 9 during monitoring years to date. Peak counts provide a general indication of continued and potentially greater use of Alena Creek post-enhancement, although among-year variability in spawner abundance is high. No Bull Trout were observed in Alena Creek in 2020.

Minnow trapping surveys, conducted to measure catch-per-unit-effort (CPUE) by species and life history stage at eight sites (five in the enhanced reaches), were conducted on September 20, 2020. Across all sites, the average Cutthroat Trout (*Oncorhynchus clarkii*) CPUE in 2020 (4.1 fish per 100 trap hours) was higher than in all previous monitoring years (except for 2014 when shorter set times led to inflated CPUE values). In all sampling years, the most abundant age class of Cutthroat Trout captured was 1+ parr, and numbers of fry were low in most years. The average Coho Salmon CPUE in 2020 was 75.1 fish per 100 trap hours, which was higher than in 2019 (33.3 fish per 100 trap hours) but lower than in 2018 (83.8 fish per 100 trap hours). CPUE across sites was higher in 2020 and 2018 than baseline (except 2014). No Bull Trout (*Salvelinus confluentus*) were captured in Alena Creek in 2020.

The enhancement in Alena Creek were designed to create habitat and increase productivity of the entire system. The capture of fish in the enhanced sites in 2020 (average CPUE 65.9 Coho/100 trap hours and 3.8 Cutthroat/100 trap hours) provides evidence of use and suggests that habitat is of high quality in the enhanced sites. The unenhanced sites had higher CPUE (average CPUE 94.4 Coho/100 trap hours and 4.9 Cutthroat/100 trap hours) indicating that they also provide high quality habitat, noting this could be due to the presence of proportionally more pool type habitat compared to the enhanced sites.

Hydrology

Seasonal trends in the Alena Creek hydrograph in 2020 were consistent with a coastal, snow-dominated watershed. Seasonal hydrograph patterns remained broadly consistent with observations from baseline and post-construction monitoring. Stage readings in 2020 remained relatively low throughout the winter (January to mid-March) when precipitation was snow dominated, then increased during snow melt in spring (March and April). Stage remained low during monitoring in late-summer and early fall (August to October) when precipitation was minimal. Stage spiked in early November.

In 2020, overall mean daily stage at Alena bridge was 0.24 ± 0.06 m. The daily maximum stage in 2020 was recorded on April 21, 2020 (0.48 m), corresponding with spring snowmelt. Stage spiked briefly in early November 2020 (0.46 m). The minimum stage in 2020 occurred on January 17, 2020 (0.18 m).

We recommend that the hydrology monitoring program continue for another year, for a total of five years post-construction as per the OEMP (Harwood *et al.* 2017).

Water Temperature

The objective of water temperature monitoring is to ensure functional conditions for spawning, incubation, and rearing by the fish species in the FHEP. Water temperature is being monitored continuously at two sites for the first five years post-construction and is being compared to the pre-construction data using a before-after-control-impact (BACI) design. Pre-construction water temperature monitoring occurred from April 17, 2013 to December 31, 2014 at the upstream site (ALE-USWQ1, upstream of all FHEP works) and from August 27, 2013 to December 31, 2014 at the downstream site (ALE-BDGWQ, located within the FHEP). Some data gaps occurred pre-construction in 2014 at the upstream site in winter/early spring 2014. No data gaps were recorded post-construction, with monitoring starting at both sites on November 23, 2016.

Analysis of the data included calculating the following temperature metrics: monthly statistics (average, minimum, and maximum water temperatures for each month of record), differences in water temperature between the upstream and downstream monitoring sites, number of days with extreme mean daily temperature (e.g., >18°C, and <1°C), the length of the growing season, exceedance of Bull Trout temperature thresholds (the species with the highest thermal sensitivity), and mean weekly maximum temperature (MWMxT). These metrics are compared to water temperature BC WQG (Oliver and Fidler 2001, MOE 2019) to assess suitability of the water temperature for aquatic life and specifically for Coho Salmon, Cutthroat Trout, and Bull Trout.

Alena Creek is a cool stream and no days with mean daily water temperatures >18°C were recorded in either pre-or post-construction periods at either site. Mean daily temperature was <1°C between zero and 19 days per year at the downstream site. Despite the small elevation (11 m) difference and short distance (~1 km) between the two sites, the downstream site exhibits greater variability in water temperature and is generally warmer than the upstream site in the summer and cooler in the winter, which is likely due to groundwater inflow and a tributary that enters Alena Creek between the two sites.

Overall, considering inter-annual variably in temperature, no substantial change in monthly temperature statistics has been observed in Year 4 in comparison to previous post-construction and pre-construction data. The daily average temperatures recorded at both sites were higher post-construction (2016-2020) than pre-construction (2013-2014) in the warmer months and the increase was more pronounced at the downstream site, likely due to the moderating effect of the groundwater inflow at the upstream site. The range in monthly average temperatures at the upstream site was 5.0°C to 8.1°C pre-construction and 4.0°C to 8.1°C post-construction (note that due to data gaps, the monthly minimum of 5.0 °C in December 2014 may not represent the coolest monthly average at this site pre-construction). At the downstream site, monthly average temperatures ranged from 2.2°C to 10.1°C pre-construction, and from 1.2°C to 11.7°C post-construction. Minimum average monthly temperatures for 2016 to 2019 occurred in December or February. In 2020, although the dataset is not yet complete, monthly average temperatures (1.9°C to 11.1°C) were within the range observed post-construction from 2016 to 2019. Instantaneous temperature ranges in the pre- (0.0°C to 14°C) and post-construction (0.0°C to 14.5°C) periods were similar.

Water temperatures at the monitoring sites were generally sub-optimally cool for Cutthroat Trout and Coho Salmon during pre- and post-construction periods, although some sub-optimally warm temperatures were recorded for Bull Trout and Cutthroat Trout incubation and spawning at the downstream site. In general, it appears the upstream site is more suitable than the downstream site for spawning and incubation of Bull Trout because there were fewer exceedances of the lower bound of the optimum temperature ranges during the winter months and fewer exceedances of the upper bound in the summer months. Warm surface waters at the upstream site during incubation stages may be partially mitigated by the groundwater inputs, such that temperature within potential redds may be lower than measured at the temperature logger.

We recommend that the monitoring program continue for another year for a total of five years post-construction based on the methodologies and schedule prescribed in the Project OEMP (Harwood *et al.* 2017).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF MAPS

LIST OF APPENDICES

1. INTRODUCTION

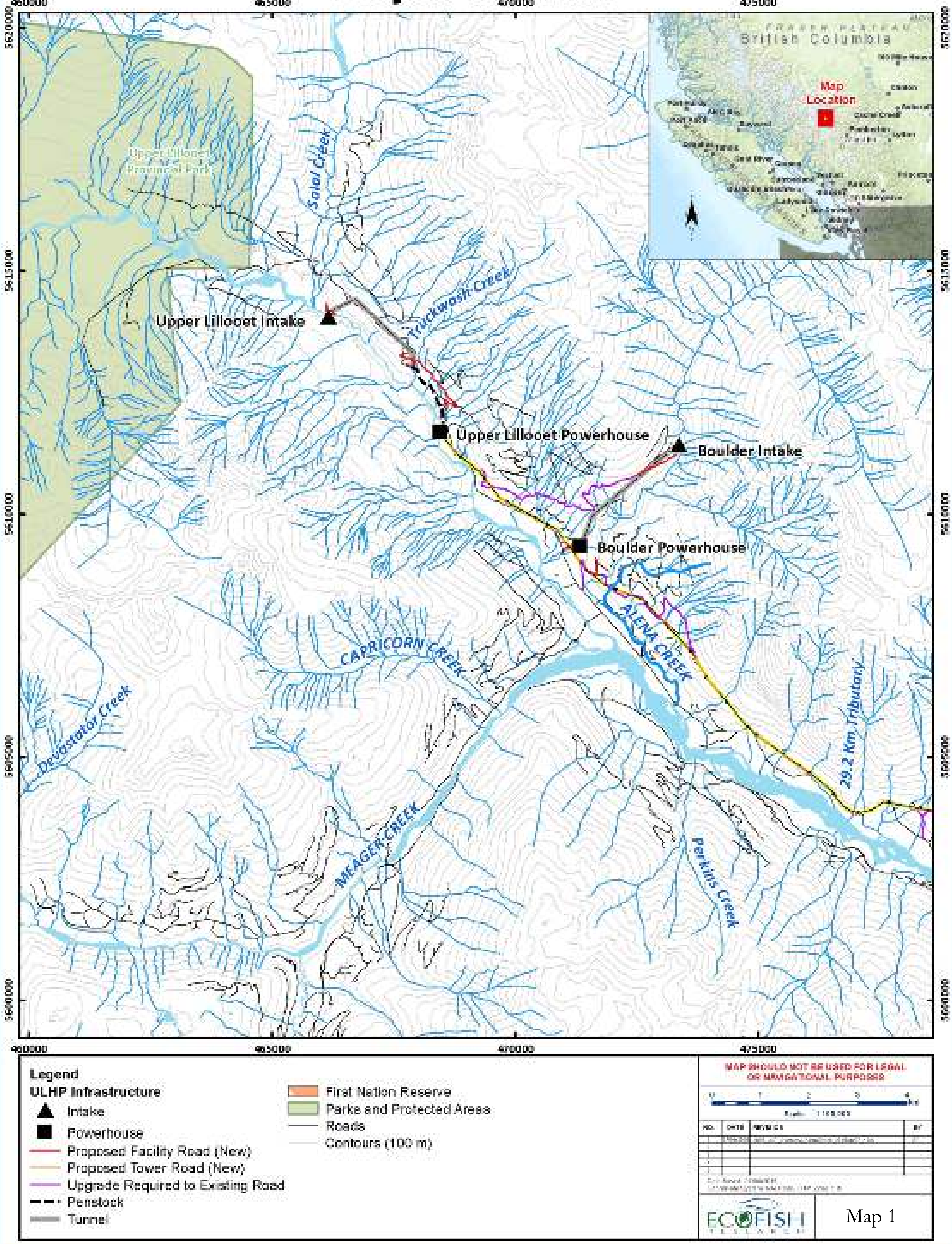
This report provides the Year 4 (2020) results of the long-term monitoring program implemented to evaluate the effectiveness of the Fish Habitat Enhancement Project (FHEP) constructed on Alena Creek (also known as Leanna Creek) as per the *Fisheries Act* Authorization (09-HPAC-PA2-00303) issued for the Upper Lillooet Hydro Project (the Project). Ecofish Research Limited (Ecofish) was retained by the Upper Lillooet River Power Limited Partnership (ULRPLP) to monitor the FHEP on Alena Creek, located northwest of Pemberton, BC. The FHEP was designed by Hemmera Envirochem Inc. (Hemmera 2015) and Ecofish (Appendix A) to offset the habitat losses incurred due to the footprint and operation of the Project. The Project is composed of two hydroelectric facilities (HEFs) on the Upper Lillooet River and Boulder Creek, and a 72-km-long 230 kV transmission line. Alena Creek is a tributary to the Upper Lillooet River located approximately 4.1 km downstream of the confluence of Boulder Creek with the Upper Lillooet River, and is therefore downstream of the two HEFs (Map 1).

Details of the predicted habitat losses incurred by Project construction and operation are provided in the aquatic and riparian footprint reports for the HEFs and the transmission line (Buchanan *et al.* 2013a, b). These habitat losses were authorized by Fisheries and Oceans Canada (DFO) through the issuance of a *Fisheries Act* Authorization (09-HPAC-PA2-00303) on September 26, 2013. The Authorization was amended on June 17, 2014. The amended Authorization requires the enhancement of 2,310 m^2 of instream habitat to offset the permanent loss of 1,935 m^2 of fish habitat associated with the construction of the Upper Lillooet HEF intake. Under the amended Authorization, there were no offset requirements associated with construction and operation of the Boulder Creek HEF, or with impacts to riparian habitat.

The offsetting plan involved fish habitat enhancement in Alena Creek, which was heavily impacted by the Capricorn/Meager Creek slide (hereafter referred to as the Meager Creek slide), which was a natural, catastrophic event that occurred on August 6, 2010 and deposited a large amount of woody debris and a thick slurry of sediment in and around Alena Creek. In addition to heavily impacting aquatic habitat, the slide affected riparian habitat by uprooting trees and smothering root systems with a thick layer of sediment. The FHEP, which was constructed in the summer of 2016, created a new section of channel, and enhanced both the aquatic and riparian habitat of Alena Creek. It will therefore benefit Coho Salmon (*Oncorhynchus kisutch*), Cutthroat Trout (*O. clarkii*), and Bull Trout (*Salvelinus confluentus*). The FHEP consists of a downstream (Reach 1) and upstream reach (Reach 3), separated by a naturally recovering low gradient reach (Reach 2) (Map 2). The actual location and geometry of constructed design features was summarized in the as-built drawings (West *et al.* 2017).

Historical fish and fish habitat data from Alena Creek, and long-term monitoring requirements for the FHEP, were originally described in the Alena Creek Long-Term Monitoring Program (Harwood *et al.* 2013). Long-term monitoring requirements were subsequently revised and integrated into Project's Operational Environmental Monitoring Plan (OEMP) (Harwood *et al.* 2017). Monitoring of the FHEP involves monitoring of six components relevant to assessing the effectiveness of the offset habitat: fish habitat, fish community, hydrology, water quality, water temperature, and riparian habitat ((Harwood *et al*. 2017). Among these, water quality monitoring was discontinued after Year 1 due to improvements observed and lack of anticipated adverse effects (Harwood et al. 2018). Monitoring was not conducted for riparian habitat in Year 4 as per the OEMP but will continue in Year 5. Results of Years 1 and 2 of Alena Creek pre-construction monitoring are documented in Harwood *et al*. (2016). Results of Year 1 through 3 (2017-2019) of post-construction monitoring are presented in Harwood *et al*. (2019a and b) and Thornton *et. al*. (2020). Results from Year 4 (2020) are summarized below.

Project Overview



2. OBJECTIVES AND BACKGROUND

2.1. Fish Habitat

FHEP habitat features (riffles and woody debris) were installed in reaches 1 and 3 to enhance fish habitat. In 2016, thirteen riffles and more than 120 pieces of large wood were installed in Reach 1 to create 1,387 m^2 of enhanced fish habitat. A total of 668 m^2 of new instream habitat and 1,139 m^2 of floodplain was created in Reach 3 in 2016. Twelve cobble riffles and over 100 pieces of large woody debris were installed in Reach 3 as part of the FHEP. A stability assessment is conducted annually to monitor the establishment and functionality of each of the FHEP habitat features to promptly identify whether any remedial action is required to maintain the effectiveness of habitat features. The assessment is conducted throughout the enhanced reaches and at eight marked transects (transects ALE-XS1 through ALE-XS4 in Rach 1, and transects ALE-XS5 through ALE-XS8 in Reach 3; Map 3), that are revisited each year so that changes over time can be tracked. Details of the habitat features installed are provided in West *et al.* (2017).

2.2. Fish Community

The goal of enhancing aquatic and riparian habitat in Alena Creek was to provide spawning and rearing habitat for Coho Salmon, Cutthroat Trout, Bull Trout, and to support equivalent or greater fish use (based on fish abundance) in Alena Creek relative to pre-project conditions. Fish habitat use in Alena Creek was assessed by comparing adult Bull Trout and Coho Salmon spawner abundance and juvenile Cutthroat Trout and Coho Salmon abundance under baseline and post-enhancement conditions. The adults were sampled by counting fish during bank walks (spawner surveys) during the Bull Trout and Coho Salmon spawning seasons in September and October, and early November to early December, respectively. Juvenile fish were sampled using minnow traps deployed at eight sites in Alena Creek (five enhanced, three unenhanced). The catch per unit effort (CPUE) for minnow trapping can be compared among years to assess changes in fish abundance over time.

2.3. Hydrology

Water level data provide useful information on inter-seasonal variation in flow and assist in interpreting changes in the other monitoring components (e.g., water temperature and fish abundance). Hydrological monitoring in Alena Creek was undertaken by ULRPLP.

2.4. Water Quality

Sampling at two sites during pre-construction monitoring and Year 1 showed that water quality in Alena Creek has generally improved since pre-construction sampling began in 2013 (Harwood *et al.* 2019). Further, monitoring data in Year 1 showed that water quality in the FHEP is generally suitable for aquatic life, including salmonids. Considering these observations, and that instream habitat enhancement is not expected to result in adverse effects on water quality, water quality sampling was discontinued after Year 1 based on a recommendation in the Year 1 annual report (Harwood *et al.* 2018).

2.5. Water Temperature

Small incremental changes in water temperature can potentially affect stream biota, including fish. Fish are vulnerable to both small increases and decreases in water temperature, with tolerance levels varying among species and life-history stages and according to existing conditions. The objective of water temperature monitoring is to ensure that conditions within the Alena Creek FHEP support functional use for migration, spawning, incubation, and rearing by the fish species present. Collection of continuous water temperature data is allowing comparison of pre- and post-construction temperature data which permits the tracking of changes within the FHEP over time. Water temperature may be influenced by the instream enhancement features and maturation of the riparian vegetation planted during the habitat restoration.

Water temperature in Alena Creek is being monitored continuously at two sites (Map 2) for the first five years post-construction. One site is located upstream of the restoration works and serves as a control site, and the other is in the downstream end of the FHEP and serves as an impact site. This Year 4 (2020) annual monitoring data report provides a summary of pre-construction (2013-2014) and post-construction (2016-2020) water temperature monitoring results. This report is intended to be primarily a data summary report; any changes in water temperature related to the construction of the FHEP will be evaluated with a BACI analysis following five years of post-construction water temperature data collection.

2.6. Riparian Habitat

Riparian areas contribute to fish habitat quality through thermal regulation, minimizing sedimentation by stabilizing stream banks and intercepting run-off, providing nutrients, and by contributing channel-stabilizing large woody debris (LWD) and cover (Gregory *et al.* 1991, Naiman and Decamps 1997,
Naiman *et al.* 2000, Richardson 2004). To provide these benefits, a goal of the Alena Creek FHEP is to expedite succession of the riparian area from an early-successional deciduous stand towards a mixed coniferous/deciduous forest. As such, the FHEP included specific restoration and enhancement prescriptions for the riparian area (defined as the terrestrial area within 30 m of the high-water mark of each bank of the stream) to increase the density of conifers and ensure success of planted vegetation (Hemmera 2015).

The objective of the riparian restoration effectiveness monitoring program, as per the OEMP, is to describe the natural regeneration and planting success of riparian vegetation qualitatively and quantitatively, and to confirm that a diversity of well-established native tree and shrub species with low observed mortality rates are present within the Alena Creek FHEP area (Harwood *et al.* 2016; Harwood *et al.* 2017). Successful revegetation is defined by several targets: 1) survival of at least 80% of vegetation between monitoring years overall (considered to be 2,309 stems/ ha and 80% cover), and of the planted western redcedar (*Thuja plicata*) stock specifically (DFO and MELP 1998; Harwood *et al.* 2013, Harwood *et al.* 2017); 2) densities equal to or more than 1,200 tree stems/ ha and 2,000 shrub stems/ha (Harwood *et al.* 2017); and 3) a diversity of healthy vegetation including a transition to a mixed conifer/ deciduous stand from a deciduous stand (Harwood *et al*. 2017, Hemmera 2015).

No monitoring was conducted in Year 4 as per the OEMP; however, monitoring will continue in Year 5 to evaluate regeneration and planting success. Results from the fifth year of monitoring will be compared with three benchmarks: 1) data collected prior to the Meager Creek slide (as estimated from typical characteristics of floodplain sites in the same biogeoclimatic zone; Green and Klinka 1994); 2) data collected four years after the slide and prior to restoration work (Harwood *et al*. 2016); and 3) as-built surveys conducted immediately following restoration work in 2016 (Harwood *et al*. 2016) and following Year 1 and 3 monitoring in 2017and 2019 respectively (Harwood *et al*. 2019, Thornton *et al*. 2020).

3. METHODS

3.1. Fish Habitat

3.1.1 Transect Repeat Photos

Reach 1 and 3 of Alena Creek were enhanced as a part of the FHEP. To assess the stability of the enhancements, initial photos were taken at photo-points established during the as-built survey (completed shortly following FHEP construction in 2016). A total of eight transects were established and surveyed at that time. At each transect, a panorama of photos was taken to support evaluation of changes in habitat conditions over time. Photos were taken looking downstream, upstream, from river left to river right, and from river right to river left. The photo aspects were oriented to provide a full view of the bankfull channel and floodplain, with the transect tape included in the photo to provide a visual reference that would aid with analysis of the topographic transect surveys. The transect photos have been repeated during each year since construction (Harwood *et al.* 2016; 2017; 2018; 2019, and Thornton *et. al.* 2020) to allow for detection of changes in channel conditions. Additional photos were also taken throughout Reach 1 and 3 at key points.

3.1.2 Instream Repairs

A high flow event occurred shortly after construction in 2016 that affected habitat features constructed for the FHEP. Since this event, sections of the channel in Reach 3 have been eroding, causing outflanking of riffles and associated bank erosion in some locations. The increased erosion and fine sediment transported throughout Reach 3 since the high flow event has caused a redistribution of flow energy that has, in turn, caused a minor reduction in the quality of riffles and large wood features at meander bends. The eroding channel banks have caused moderate widening of the channel and associated deposition of fine sediment. These issues have largely stabilized; however, at some locations there remained a risk that more severe erosion could occur during future high flow events. To reduce this risk, it was determined that hand repairs could be completed to protect banks and redirect flow energy. On August 6, 2020, during the least risk timing window (MOE 2009), a crew of four staff from Ecofish and Lil’wat First Nation completed the repairs by hand. The repairs included the following actions:

1. Eroding banks were stabilized by creating a revetment composed of cobble, small boulder, and large wood.
2. Flow deflectors were installed to direct flow energy away from banks and towards root wad complexes in pools that have partially infilled with fines. Flow deflector were composed of a matrix of materials ranging in size from sand to small boulders and large wood.
3. Riffles that had been outflanked were rebuilt and contoured to prevent further bank erosion and keep flow energy focused on gravel deposits for cleaning purposes.
4. Gravel was redistributed from pools and slack water areas into pool tail-outs and riffles where spawning might occur.

Reach 1 was generally found to be stable after the high flow event except for one location where a channel spanning log had collapsed, creating a wood jam and minor avulsion of the channel around the jam. The channel at this location had largely stabilized and was not expected to continue eroding at an unnatural rate. Repairs at this location were restricted to placement of cobble along portion of the avulsed channel that would direct flow energy away from the channel bank and back towards the original channel alignment.

3.2. Fish Community

3.2.1 Adult Spawner Abundance

Spawner surveys in Alena Creek focused on Coho Salmon; however, Bull Trout were also monitored to provide additional information on project streams (i.e., Upper Lillooet and Boulder Creek). Spawner surveys for Bull Trout were done through bank walks conducted approximately every two weeks between September 16 and October 19, 2020 (a total of three surveys). Coho spawner surveys were conducted every two weeks between November 7 and December 4, 2020 (a total of three surveys). Consistent with previous years, bank walks, during which both live fish and carcasses were counted, occurred from the downstream confluence with the Upper Lillooet River to the upstream end of Alena Creek at the groundwater spring at the Lillooet River Forest Service Road (FSR) crossing at kilometer 36.5. Due to the meandering nature of the Upper Lillooet River, the downstream confluence with Alena Creek has varied over the monitoring years by up to ~1 km.

It is important to note that the carcasses counted in Alena Creek are quickly consumed by wildlife in the area, as evident by observations that they are not often whole and show signs of being eaten. Often only the pyloric caeca, which animals prefer not to eat, are left behind.

3.2.2 Juvenile Abundance

3.2.2.1. Minnow Trapping

Minnow trapping surveys were conducted in Alena Creek commencing in Year 4 on September 20, 2020. The objective of minnow trapping was to monitor the change among years in the relative abundance of juvenile fish, based on catch-per-unit-effort (CPUE), for individual species and life stages in the enhanced and unenhanced reaches of Alena Creek (Map 3).

Eight sites were sampled in 2018, 2019, and 2020 (five enhanced, three unenhanced), whereas six were sampled in previous years. Four to 10 traps were installed at each site. At ALE-MT06, 10 traps were set because the large pool present at this site required a higher level of sampling effort. Sampling was conducted in five of the six sites sampled in previous years (ALE-MT01, ALE-MT02, ALE-MT03, ALE-MT05 and ALE-MT06); however, due to American Beaver (*Castor canadensis*) (hereafter, beaver) activity in previous years, sampling at ALE-MT04 was discontinued in 2018 through 2020 as recommended in the Year 1 report (Harwood *et al.* 2019). Additionally, three new sites established in 2018 in FHEP habitat were sampled, specifically one site in Reach 1 (ALE-MT07) and two sites in Reach 3 (ALE-MT08 and ALE-09; Map 3). The Year 1 report had recommended that one of the additional sites be located just upstream of Reach 1 at the gravel augmentation pile installed as part of the enhancement works; however, due to beaver dam and stability issues at this location, the site was located just downstream of the gravel augmentation pile and in the Reach 1 FHEP area (ALE-MT07).

The minnow traps were baited using salmon roe and left overnight. When the traps were retrieved, captured fish were identified and measured (discussed below), then released.

3.2.2.2. Biological Information

All captured fish were enumerated and identified to species using standard field keys. Due to the volume of fish captured, only a subset at each site were measured for fork length using a measuring board (±1.0 mm) and weighed using a field scale (±0.1 g).

Scale samples to be used for aging were taken from a sub-sample of captured fish and these were aged at the Ecofish laboratory in Campbell River. For each fish included in the sub-sample, three representative scales were examined under a dissecting microscope, photographed, and apparent annuli noted on a digital image. Fish age was determined by a biologist and QA'd by a senior biologist. Where discrepancies were identified, they were discussed, and final age determination was based on the professional judgement of the senior biologist.

3.2.2.3. Data Analysis

Individual Fish Data

Biological data from the captured fish were analyzed to define the age structure, size structure, length-weight relationship, length at age, and condition factor by species. Discrete age classes were based on size bins established using length-frequency histograms and age data from the scale analysis. Discrete age classes were defined for fry (0+), parr (1+), parr (2+), and adults (3+). These discrete classes allowed measured fish to be assigned an age class based on fork length.

The condition of fish, which is an indication of overall health, can be calculated in a variety of ways, such as Fulton K or relative weight (W_r) (Blackwell *et al.* 2000). A potential problem with the use of Fulton K is an assumption of isometric growth (Blackwell *et al.* 2000); however, for this monitoring program the condition of fish was calculated separately for each age class, so violations of this assumption were not expected. The condition of fish was assessed by calculating Fulton's condition factor (*K*) and creating plots of species-specific length-weight relationships. Fulton's condition factor (*K*) was calculated for each fish captured by species and year using the following equation:

$$K = \left(\frac{W}{L^3}\right) 100{,}000$$

where W is the weight in g, L is the length in mm, and $100{,}000$ is a scaling constant (Blackwell *et al.* 2000).

Relative Abundance

Relative abundance was evaluated using CPUE for minnow trap data, which was calculated as the number of fish captured per 100 trap hours.

3.3. Hydrology

Water level monitoring began at Alena Creek in April 2013. Two water level loggers were originally installed in Alena Creek: one at the Lillooet River FSR crossing (Alena Bridge) and another at the upstream end of the project area (Alena Upstream) (Map 2). Baseline monitoring at these two stations occurred from approximately 2013 to 2015. Post-construction monitoring started in 2016 and is ongoing. Pos-construction water level data has been collected at the Alena Bridge site in every monitoring year. The gauge was reinstalled and moved slightly on November 26, 2019. An offset was applied to data collected after that point to ensure stage data collected before and after removal was comparable.

In addition, a second gauge (R1) was installed based on recommendation by Harwood *et al.* (2018), at approximately 125 m upstream from the Alena Bridge gauge. This gauge was deployed from August 23, 2018 until fall 2019. The purpose of the second gauge was to examine for potential backwater effects that may be caused by the Upper Lillooet River side channel when flows were high, and to ensure the stage data collected were representative of Alena Creek water levels. Results from the Year 3 report (Thornton *et al.* 2020) indicated that backwatering from Upper Lillooet River to the FSR bridge was no longer occurring, and the gauge was removed in November 2019.

3.4. Water Temperature

3.4.1 Data Analysis and Collection

Pre-construction and post-construction water temperature monitoring occurred at two monitoring sites: ALE-USWQ1, located upstream of the enhancement works, and ALE-BDGWQ, located at the downstream end of the works, within the enhanced area and just upstream of the FSR bridge (Table 1, Map 2, Appendix B). Pre-construction water temperature monitoring occurred from April 17, 2013 to December 31, 2014 at the upstream control site (ALE-USWQ1) and from August 27, 2013 to December 31, 2014 at the downstream impact site (ALE-BDGWQ) (Map 2). Post-construction monitoring commenced at both sites on November 23, 2016. Year 4 data are available up to September 21, 2020 for the upstream site and downstream site (Table 1).

Pre-construction temperature data were recorded at 60-minute intervals using hydrometric gauges maintained by KPL. The temperature sensors incorporated into the gauges were installed in aluminum standpipes and had an accuracy of ±0.3°C and a resolution of ±0.001°C. Post-construction temperature data were recorded at 15-minute intervals using self-contained Tidbit v2 loggers made by Onset. The loggers have a range of -20°C to +70°C, are accurate to ±0.2°C, and have a resolution of 0.02°C. Water temperature at ALE-BDGWQ was concurrently logged by two Onset Tidbit loggers installed on separate anchors; this redundancy ensured availability of data in case one of the loggers malfunctioned or was lost. A second Tidbit logger was installed at ALE-USWQ1 in 2019.

Processing of water temperature data was conducted by first identifying and removing outliers and then compiling data into a time series for all sites. Identification and removal of outliers was conducted as part of a thorough Quality Assurance/Quality Control (QA/QC) process which ensured that any suspect or unreliable data were excluded from analysis and presentation Excluded data included, for example, data where the sensor was suspected of being out of the water, affected by snow or ice, or buried in sediment.

During the pre-construction monitoring period, there were gaps in the datasets from mid January 2014 to mid-March 2014 at the upstream site, and from the end of March through early April 2014 at the downstream site due to the suspected build-up of ice (McCarthy, pers. comm. 2014) (Table 1). At the upstream site, less than three weeks of water temperature data were available for January, February, and March 2014. Therefore, not all summary statistics and temperature metrics (see Section 3.4.1) could be calculated for these months, limiting the available winter season pre-construction data (Table 1). At the downstream site, less than three weeks of data were available for March 2014, limiting the available spring season pre-construction data (Table 1). There have been no data gaps post-construction to date (i.e., data set is 100 % complete; Table 1).

Table 1. Summary of water temperature site names, logging details, and period of data record in Alena Creek pre-construction (2013, 2014) and post-construction (November 2016 through 2020).

Type	Site	UTM Coordinates (10U)		Elevation (masl)[1]	Project Phase	Periods of Record		Number of Data Records	Logging Interval (min.)	No. of Days with Valid Data	% Complete[2]
		Easting	Northing			Start Date	End Date				
Upstream	ALE-USWQ1	472,976	5,606,870	391	Pre-Construction	17-Apr-13	30-Dec-14	623	60	561	91
					Post-construction	23-Nov-16	21-Sep-20	1,399	15	1,395	100
Downstream	ALE-BDGWQ	473,336	5,606,095	382	Pre-construction	27-Aug-13	30-Dec-14	491	60	453	93.6
					Post-construction	23-Nov-16	21-Sep-20	1,399	15	1,396	100

[1] Estimated from Google Earth.

Pre-construction (2013-2014) water temperature was monitored via hydrometric gauges maintained by KPL. Post-construction Tidbit temperature loggers were installed.

[2] The pre-construction data gap at the upstream site occurred between mid January and mid March 2014 due to icing concerns.

The pre-construction data gap at the downstream site occurred at the end of March through early April 2014, therefore a complete month of data (i.e., more than three weeks) for March are not available during this phase.

After identifying and removing outliers, the records from duplicate loggers were averaged and records from different download dates were combined into a single time-series for each monitoring site. The time series for all sites were then interpolated to a regular interval of 15 minutes (where data were not already logged on a 15-minute interval), starting at the full hour. Data are presented in plots that were generated from the resultant 15-minute interval temperature data.

Analysis of the data involved computing the following summary statistics: monthly statistics (mean, minimum, and maximum water temperatures for each month of record, as well as differences in water temperature among sites), days with extreme mean daily temperature (e.g., >18°C and <1°C), days with exceedances of the minimum and maximum Bull Trout temperature thresholds, the length of the growing season, the accumulated thermal units in the growing season (i.e., degree days), hourly rates of temperature change, and mean weekly maximum temperature (MWMxT). Table 2 defines these statistics and describes how they were calculated. The calculation of the end date of the length of the growing season (as defined in Table 2) was modified from 4°C (as per Coleman and Fausch 2007) to 5°C, because the MWMxTs at the upstream site were >4°C in the winter data set for the first year of pre-construction monitoring.

After Year 3 reporting, data underwent updated analysis to ensure it was processed according to current standards. As a result, some revisions were made to improve accuracy, and the values presented herein may differ from those presented in previous reports during Year 1 to Year 3. Some of the changes included:

- Hourly Rates of Water Temperature Change - the percentage of records after Year 3 were calculated as the total # of valid hourly change records with a rate of change >1ºC, whereas some data prior to Year 3 included the total # of temperature records, rather than valid records.
- Mean Weekly Maximum Temperature (MWMxT) - changes from previous versions of this analysis were:
    - The inclusion of a cut-off whereby a day is excluded from the calculation if it does not include data during the warmest period of the day. By default, a day is excluded when it does not have at least one hourly measurement between 11:00 and 18:00.
    - For growing season, a "week" was calculated as a centred average (i.e., three days before and three days after the day for which MWMxT is being calculated). Therefore, the computed start and end date of the growing season are three days later/earlier, respectively.
- Growing Season Statistics - start and end dates for weekly averages are defined after Year 3 in terms of calendar weeks (the start/end dates reported are the start of the calendar week containing the day the threshold was crossed), resulting in a change in start/end dates of ± 3 days. In some pre-Year 3 data, running weekly averages were calculated, and the start/end

dates were defined as the date the threshold was crossed minus three days (i.e., a centered weekly average).

Table 2. Water temperature metrics and method of calculation.

Metric	Description	Method of Calculation
Water temperature	Hourly or 15 minute data	Data (interpolated to 15 minute intervals where necessary) presented in graphical form.
Monthly statistics	Mean, minimum, and maximum on a monthly basis	Calculated from 15 minute data (interpolated where necessary) and presented in tabular format.
Rate of water temperature change	Hourly rate of change	Calculated from 15 minute data (interpolated where necessary); presented in summary tables and graphical form.
Degree days in growing season[1]	The beginning of the growing season is defined as the beginning of the first week that mean stream temperatures exceed and remain above 5°C; the end of the growing season was defined as the last day of the first week that mean stream temperature dropped below 4°C (as per Coleman and Fausch 2007).	Daily mean water temperatures were summed over this period (i.e., from the first day of the first week when weekly mean temperatures reached and remained above 5°C until the last day of the first week when weekly mean temperature dropped below 4°C).
Number of Days of Extreme Daily Mean Temperature	Daily average temperature extremes for all streams	Total number of days with daily mean water temperature >18^{o}C , >20^{o}C , and <1^{o}C.
Number of Days of Exceedance	Daily maximum and minimum temperature thresholds for streams with Bull Trout / Dolly Varden	# days maximum daily temperature is >15°C; # days maximum incubation temperature is >10°C; # days minimum incubation temperature is <2°C; # days maximum spawning temperature is >10°C.
MWMxT (Mean Weekly Maximum Temperature)	Mean, minimum, and maximum on a running weekly (7 day) basis	Mean of the warmest daily maximum water temperature based on hourly data for 7 consecutive days; e.g., if MWMxT = 15°C on August 1, 2008, this is the mean of the daily maximum water temperatures from July 29 to August 4, 2008; this is calculated for every day of the year.

[1]The end of the growing season was defined as the last day of the first week that mean stream temperatures dropped below 5°C for Alena Creek.

3.4.1.1. Applicable Guidelines

The water temperature BC Water Quality Guidelines (BC WQG) for the protection of aquatic life (as per Oliver and Fidler 2001, MOE 2019) define water temperature thresholds and optimum temperature ranges specific to fish species and life stages. The fish community in Alena Creek consists of Coho Salmon, Cutthroat Trout, and Bull Trout. The water temperature BC Water Quality

Guidelines (BC WQG) for the protection of aquatic life (as per Oliver and Fidler 2001, MOE 2019) relevant to the summary statistics produced for this monitoring program are summarized below. Optimum water temperature ranges, as defined by the BC WQG for rearing, spawning, incubation, are provided for the fish species present in Alena Creek in Table 3. The timing of life history stages in Alena Creek (Harwood *et al.* 2016) that were used to define the start and end dates for each of the applicable life stages for Coho Salmon, Cutthroat Trout, and Bull Trout are shown in Table 4.

Table 3. Optimum water temperature ranges for Coho Salmon, Cutthroat Trout, and Bull Trout during spawning, incubation, rearing, and migration (MOE 2019).

Species	Optimum Water Temperature Range (°C)			
	Spawning	Incubation	Rearing	Migration
Coho Salmon	4.4 - 12.8	4.0 - 13.0	9.0 - 16.0	7.2 - 15.6
Cutthroat Trout	9.0 - 12.0	9.0 - 12.0	7.0 - 16.0	-
Bull Trout	5.0 - 9.0	2.0 - 6.0	6.0 - 14.0	-

The BC WQG for water temperature is ± 1°C outside the optimum temperature range for each life stage.

Table 4. Periodicity of fish species in Alena Creek.

Coho Salmon	Cutthroat Trout	Bull Trout
Spawning (Oct. 15 to Jan. 01)	Spawning (Apr. 01 to Jul. 01)	Spawning (Aug. 01 to Dec. 08)
Incubation (Oct. 15 to Apr. 01)	Incubation (May. 01 to Sep. 01)	Incubation (Aug. 01 to Mar. 01)
Rearing (Jan. 01 to Dec. 31)	Rearing (Jan. 01 to Dec. 31)	Rearing (Jan. 01 to Dec. 31)
Migration (Sep. 01 to Dec. 31)	-	-

Hourly Rates of Water Temperature Change

Rapid changes in heating or cooling of water temperature can affect fish growth and survival (Oliver and Fidler 2001). Hourly rates of change in water temperature were compared to the BC WQG, which specifies that the hourly rate of water temperature change should not exceed ±1.0°C/hr (MOE 2019).

Daily Temperature Extremes

Extreme cold or warm temperatures can also affect fish survival and productivity. The number of days when the daily mean temperature was <1°C, were calculated. Alena Creek is a cool stream where maximum temperatures recorded to date did not exceed 15°C, therefore extreme warm temperatures (>18°C) have not occurred. Thus, the number of days >18°C and >20°C, which are typically calculated for water temperature monitoring in relation to fish habitat, are not applicable. The maximum optimum temperature for the fish species present in the Project area is 16°C (Coho Salmon and Cutthroat Trout rearing life stage, Table 3).

Mean Weekly Maximum Temperature (MWMxT)

The MWMxT is an important indicator of prolonged periods of cold and warm water temperatures that fish are exposed to. The BC WQG for the protection of aquatic life states "Where fish distribution information is available, then mean weekly maximum water temperatures should only vary by ±1.0°C beyond the optimum temperature range of each life history phase (incubation, rearing, migration and spawning) for the most sensitive salmonid species present" (Oliver and Fidler 2001, MOE 2019). Accordingly, MWMxT values were compared to the optimum temperature ranges for the fish species present in Alena Creek based on the life history and periodicity (Table 3, Table 4).

Within each life history period, the completeness of the temperature data record (% complete) was calculated and results are only included if at least 50% of the data for the period was available. The minimum and maximum MWMxT values, % data within the optimum range, and % exceedance of ±1.0°C of the optimal temperature range was calculated for each life history period to evaluate the suitability of the temperature regime for each fish species at each monitoring site, pre- and post-construction.

Bull Trout Temperature Guidelines

Additional BC WQG (MOE 2019) water temperature guidelines are specified for streams with Bull Trout and Dolly Varden (Oliver and Fidler 2001; Table 1 in Appendix C). When either of these fish species are present, the guidelines state that:

- Maximum daily water temperature is 15°C;
- Maximum daily incubation temperature is 10°C;
- Minimum daily incubation temperature is 2°C; and
- Maximum daily spawning temperature is 10°C.

The number of days where these thresholds were exceeded were calculated using the appropriate daily maximum or minimum temperature values for each site where Bull Trout are present (Table 2).

4. RESULTS

4.1. Fish Habitat

4.1.1. Overview

Photos were taken at established photo-point locations in the enhanced reaches (Reach 1 and Reach 3) of Alena Creek on November 7, 2020. A comparison of all photos is available in Appendix D. Overall, the riparian vegetation has increased since 2016 and the channel has remained stable over this time. Grasses and herbaceous vegetation continue to establish well throughout the reaches and protect the bank from excessive erosion, while also providing cover for small salmonids. No substantial changes to the stream channel were noted that were not anticipated based on the dynamic stability criteria of the design.

New beaver activity was observed in the lower end of Reach 3. Previous beaver activity upstream of Reach 3 had ceased, but flow was still being partially diverted around the upper portion of Reach 3. Beavers were trapped within the Alena Creek enhancement area and the dams were removed in the fall of 2020 by a licensed trapper from EBB Environmental Consulting Inc. A description of channel condition, geomorphic processes, and instream repairs is provided for the two reaches in the following sections. Instream repairs completed on August 6, 2020 are also described in the following sections.

4.1.2. Reach 1

Reach 1 is the most downstream reach of Alena Creek; it extends up from the Lillooet River FSR bridge to approximately 200 m upstream (Map 3) . Photos of each transect from each year of monitoring are provided in Appendix D. A summary of observations of constructed features at each transect and repairs made near ALE-XS1 in 2020 are provided below:

- **ALE-XS1** – The channel had previously avulsed onto the river left floodplain and created a secondary channel less than 10 m long (Figure 1 to Figure 6). This channel appears to have been more active in 2020 than 2019, but this could be a result of differences in flows between surveys. The riffle is still composed of gravel and is relatively free of fines but has some algae growth. Cobble was placed upstream of ALE-XS1 along a portion of the avulsed channel to direct flows back to the original channel alignment and reduce bank erosion (Figure 6). There are no concerns for long term stability.

- **ALE-XS2** – The channel is backwatered in this location due to the collapse of one of the channel-spanning logs downstream, and the accumulation of small wood pieces have created a minor log jam (Figure 7). The collapse was identified during the 2019 assessment (Thornton *et al*. 2020). Some undercutting has occurred on river left under a longitudinally aligned log, which appears to be stable and has created good cover habitat. The root wads on river right continue to provide good cover habitat. The log jam has not grown but should be monitored closely in future years to ensure the jam is not causing excessive fines deposition or full channel avulsion.

- **ALE-XS3** - Channel hydraulic diversity remains as designed, and the riffle has low fines content. There are no concerns for long term stability.

- **ALE-XS4** – Pool depth has remained as designed with minimal aggradation of fines. Root wads continue to provide good cover conditions. There are no concerns for long term stability.

Figure 1. Looking from river left to river right at ALE-XS1 on September 19, 2016.

Figure 2. Looking from river left to river right at ALE-XS1 on November 10, 2017.

Figure 3. Looking from river left to river right at ALE-XS1 on November 5, 2018.

Figure 4. Looking from river left to river right at ALE-XS1 on November 13, 2019.

Figure 5. Looking from river left to river right at ALE-XS1 on November 7, 2020.

Figure 6. Cobble placement at the head of the side channel upstream of ALE-XS1 on August 06, 2020.

Figure 7. Log jam that has formed at a collapsed channel spanning log approximately 10 m upstream of at ALE-XS1. Photo taken on June 20, 2019.

4.1.3. Reach 3

4.1.3.1. Transect Repeat Photos

Reach 3 extends from approximately 600 m to 800 m upstream of the Lillooet River FSR bridge. A brief description of changes that have occurred to constructed features at each of the monitoring transects is provided below, followed by an overview description of changes occurring in the channel. Photos of at each transect from each year of monitoring are provided in Appendix D.

- **ALE-XS5**- Due to recent beaver activity in 2020 at the lower end of Reach 3, this section is moderately backwatered. Wetted widths and wetted depths have increased relative to 2019. Channel hydraulic diversity remains as designed, and the riffle has low fines content despite moderate bank erosion upstream. One channel-spanning log has collapsed but is only slightly affecting hydraulics. Rootwads upstream of the riffle continue to provide good cover for juvenile salmonids. There are no concerns for long term stability.

- **ALE-XS6** - A new beaver dam was constructed in this section, causing some moderate backwatering and sand deposition. Wetted widths and wetted depths have increased relative to 2019. Some sand deposition has occurred on riffle material, with sand likely originating partially from upstream supply and from bank erosion that largely occurred during the November 2016 high flow event. Grass and herbaceous bank vegetation have established that should prevent excessive erosion in the future. There are no concerns for long term stability.

- **ALE-XS7** – The pool has aggregated with sand to some extent and may now be at an equilibrium depth with the upstream sand supply. There has been an increase in deposition of sand mid channel since 2019. Rootwads continue to provide cover habitat, and riffles are generally free of fines. There are no concerns for long term stability.
- **ALE-XS8** – The riffle is still relatively free of fines and excessive erosion has not occurred. Deposition of fines has occurred on the glide that is unavoidable given upstream sediment supply and the newly cut side channel flowing into the top of Reach 3. There are no concerns for long term stability.

During Year 3 (2019), two channels were identified that formed on the west side of Reach 3 due to a large beaver pond approximately 30–50 m upstream of Reach 3. These channels are cutting into fine sediment and delivering it to Reach 3. The channel that enters Reach 3 approximately 40 m downstream from the head of Reach 3 was flowing throughout 2020 (Figure 8). The other channel that entered Reach 3 further downstream had ceased flowing during 2020, likely due to changes in upstream beaver activity. The beaver dam complex upstream of Reach 3 was considered inactive in 2020. The dams restrict fish migration to the upstream spawning reach, impede gravel supply to Reach 3, and cause diversion of flow around the Reach 3 constructed channel. The dams were managed through 2018, 2019, and 2020 in accordance with best management practices for dam removal provided by a licensed trapper from EBB Environmental Consulting Inc. As recommended in 2019, the dam that is blocking flow to the mainstem was lowered in order to prevent excessive flow diversion.

New beaver activity was observed in the lower end of Reach 3: two constructed beaver dams created moderate backwatering at ALE-XS5, ALE-XS6 and ALE-XS7 (Figure 9). Beavers were trapped within the Alena Creek enhancement area and dams were removed in the fall of 2020 by a licensed trapper from EBB Environmental Consulting Inc.

Figure 8. **Confluence of overflow channel that formed during 2019 as a result of beaver activity upstream of Reach 3. Photo shows uppermost 20 m of Reach 3 (right) and overflow channel (left). Photo taken on November 13, 2019.**

Figure 9. **New Beaver dam at the lower end of Reach 3 that was identified during fall 2020 and subsequently removed.**

4.1.3.2. Instream repairs

As recommended in 2019, instream repairs were completed in Reach 3 on August 6, 2020. The repairs were distributed throughout the reach: conditions were enhanced, and erosion protection was installed at roughly every other habitat unit (pool or riffle). A set of example photos illustrating the repairs completed are provided below in Figure 10 to Figure 17, with before repair and after repair photos shown where feasible. The photos are generally shown from downstream to upstream and were all taken on August 6, 2020. Examples including repairs of each type are:

Bank revetments: Figure 10, Figure 12, Figure 13, Figure 14, and Figure 16.

Flow deflectors: Figure 11, Figure 12, and Figure 13.

Rebuild riffle: Figure 10, Figure 16, and Figure 17.

Gravel redistribution: Figure 12 and Figure 15.

Figure 10. Repaired riffle crest and bank protection at downstream extent of Reach 3 near ALE-XS5, before (left) and after (right) repair. Flow is from left to right. Riffle was backwatered by beaver dam at the time of photo. River right wetted terrace is composed of coarse material that is not expected to erode.

Figure 11. **Instream repair near ALE-XS6, before (left) and after (right) repair. Flow is from right to left. Rock/wood flood deflector was installed to scour sand deposited under root wads and to focus flow back into the original channel alignment.**

Figure 12. **Bank erosion repair and gravel redistribution to create flow deflector near ALE-XS6, before (left) and after (right) repair. Flow is from bottom to top. Flow energy is concentrated away from eroding left bank and towards rootwads on river right.**

Figure 13. **Flow deflector and bank stabilization installed at ALE-XS6, after repair. Flow in left photo is from right to left and arrow shows new deflector. Flow in right photo is from left to right and shows how redirected flow energy has already begun to clean out material deposited at base of root wads.**

Figure 14. **Bank stabilization repairs using cobble above ALE-XS7. Flow is from right to left.**

Figure 15. Pool dug out near ALE-XS7, showing gravel redistributed to centre of channel. Flow is from bottom to top.

Figure 16. Restored riffle crest above ALE-XS7 before (left) and after (right) repair. Flow is from left to right.

Figure 17. Restored riffle crest and bank protection near ALE-XS8, before (left) and after (right) repair. Flow is from left to right.

4.2. Fish Community

4.2.1. Adult Spawner Abundance

The peak count of Coho Salmon spawners observed in 2020 was 218 live fish and 51 carcasses on November 19, 2020 and December 4, 2020, respectively (Table 5). The peak count of 218 adult spawning Coho Salmon in 2020 was the highest observed during monitoring to date. Previous peak counts of adult spawning Coho Salmon ranged from 111 to 192 (in 2011 and 2016 respectively) (Table 6). A comparison of observations among years also highlights the variability in run timing, with the annual peak live count recorded on November 5 in 2010 and 2018, November 14 in 2016, December 5 in 2017, December 9 in 2019, and November 19 in 2020. The peak counts provide a general indication of use and demonstrate that Alena Creek supports potentially greater use by Coho Salmon spawners currently than it did pre-enhancement, although among-year variability in spawner abundance is strongly affected by factors other than spawning habitat quality, such as marine survival. Example photos of adult Coho Salmon holding in enhanced habitat and unenhanced habitat on November 7, 2020 are provided in Figure 18 and Figure 19 respectively. No Bull Trout were observed in 2020, while counts in previous years ranged from one to nine (Table 5, Table 7).

Table 5. Summary of adult fish observed during fall spawner surveys in 2020.

Stream	Date	Survey Time (hh:mm)	Survey Distance (m)	Live Adults [1]		Adult Carcasses [1]	
				BT	CO	BT	CO
Alena Creek	16-Sep-20	01:30	1,750	0	0	0	0
	2-Oct-20	01:27	2,300	0	0	0	0
	21-Oct-20	01:31	2,300	0	0	0	0
	7-Nov-20	03:41	2,300	0	206	0	7
	19-Nov-20	03:12	2,300	0	218	0	51
	4-Dec-20	03:56	2,300	0	77	0	75
Alena Creek Total:		**15:17**	**13,250**	**0**	**501**	**0**	**133**

[1] BT = Bull Trout, CO = Coho Salmon

Table 6. Peak Coho Salmon spawner counts during baseline (2010-2011) and post-construction monitoring (2016 - 2020).

Year	Date [1]	Adult Spawning Coho		
		Live	Dead	Total
2010	5-Nov	127	0	127
2011	2-Dec	110	1	111
2016	27-Nov	174	18	192
2017	5-Dec	110	22	132
2018	5-Nov	126	0	126
2019	9-Dec	153	20	173
2020	19-Nov	218	51	269

[1] Date of adult spawning Coho Salmon peak count

Table 7. Peak Bull Trout spawner counts during baseline (2011) and post-construction monitoring (2018 - 2020).

Year	Date [1]	Adult Spawning Bull Trout		
		Live	Dead	Total
2011	4-Oct	9	0	9
2018	11-Oct	2	0	2
2019	1-Oct	1	0	1
2020	N/A	0	0	0

[1] Date of adult spawning Bull Trout peak count

Figure 18. Coho Salmon observed holding in enhanced habitat on November 7, 2020.

Figure 19. Spawning Coho Salmon observed in unenhanced habitat on November 7, 2020.

4.2.2. Juvenile Abundance

4.2.2.1. Overview

On September 20, 2020, 44 minnow traps were set overnight in riffle, pool, and glide habitats ranging in depth from 0.2 to 1.1 m (Table 8). A total of 981 fish (932 Coho Salmon and 49 Cutthroat Trout) were captured during minnow trap sampling (Table 8). No juvenile Bull Trout were captured in 2020. Raw data tables and representative photos of minnow trapping sites are presented in Appendix E.

Table 8. Summary of minnow trapping habitat characteristics and fish captures in Alena Creek on September 20, 2020.

Site	Date	Enhancement Status	# of Traps	Total Soak Time (hrs)	Mesh Size (mm)	Habitat Type	Trap Depth Range (m)	Total Captures		
								BT	CO	CT
ALE-MT01	20-Sep-20	Enhanced	5	110.4	3	Glide, Riffle	0.3 - 0.4	0	30	5
ALE-MT02	20-Sep-20	Enhanced	5	113.3	3	Pool, Riffle	0.2 - 0.5	0	25	5
ALE-MT07	20-Sep-20	Enhanced	5	117.8	3	Pool	0.2 - 0.7	0	54	3
ALE-MT03	20-Sep-20	Unenhanced	4	97.0	3	Pool, Glide	0.2 - 0.7	0	57	5
ALE-MT08	20-Sep-20	Unenhanced	5	130.0	3-6	Pool	0.7 - 1.1	0	104	3
ALE-MT09	20-Sep-20	Enhanced	5	131.5	6	Pool, Riffle	0.2 - 0.4	0	103	9
ALE-MT05	20-Sep-20	Enhanced	5	131.3	6	Pool, Riffle	0.4 - 0.5	0	205	1
ALE-MT06	20-Sep-20	Unenhanced	10	245.0	6	Pool	0.4 - 1.4	0	354	18
Grand Total:			**44**	**1,076.2**				**0**	**932**	**49**
Grand Average:			**5.5**	**134.5**				**0**	**117**	**6**

4.2.2.2. Cutthroat Trout

A total of 49 Cutthroat Trout, ranging in length from 55 mm to 160 mm, were captured during the 2020 sampling program (Table 9, Table 10). Catch per unit effort (CPUE) ranged from 0.8 fish per 100 trap hours at ALE-MT05 to 7.3 fish per 100 trap hours in ALE-MT06 (Table 9). The average CPUE was 4.2 fish per 100 trap hours (± 2.3 Standard Deviation (SD)) (Table 9). Summary statistics of fish length, weight, and condition factor are presented for each age class in Table 10. Discrete fork length ranges were defined for each age class (Table 11), based on a review of the length-frequency histogram (Figure 20) and aging data from scale analysis (Figure 21).

Cutthroat Trout Fry (0+)

A single Cutthroat Trout fry (0+) was captured in 2020 at ALE-MT06 (unenhanced) and at ALE-MT09 (enhanced) (Table 9).

Cutthroat Trout Parr (1+)

Cutthroat Trout parr (1+) were distributed throughout Alena Creek and were captured at all sites except for ALE-MT05 (unenhanced) (Table 9). A total of 30 Cutthroat Trout 1+ parr were captured, with the largest number of fish captured in ALE-MT06 (unenhanced) and ALE-MT09 (enhanced).

Cutthroat Trout Parr (2+)

Eight Cutthroat Trout 2+ parr were captured in 2020. They were captured at all sites except ALE-MT05 (unenhanced), ALE-MT07 (enhanced), and ALE-MT08 (unenhanced) (Table 9).

Cutthroat Trout Adults (≥3+)

A total of 3 adult Cutthroat Trout were captured in 2020 at ALE-MT06 (unenhanced) (Table 9).

Table 9. Catch and CPUE for Cutthroat Trout captured by minnow trapping in Alena Creek in 2020.

Site	Date	Enhancement Status	# of Traps	Total Soak Time (hrs)	Total CT Catch (# of Fish) [1]	CPUE (# of Fish/100 Trap hrs) [1]	Aged CT Catch (# of Fish)[2]				
							0+	1+	2+	3+	All
ALE-MT01	20-Sep-20	Enhanced	5	110.4	5	4.5	0	4	1	0	**5**
ALE-MT02	20-Sep-20	Enhanced	5	113.3	5	4.4	0	4	1	0	**5**
ALE-MT07	20-Sep-20	Enhanced	5	117.8	3	2.5	0	3	0	0	**3**
ALE-MT03	20-Sep-20	Unenhanced	4	97.0	5	5.2	0	4	1	0	**5**
ALE-MT08	20-Sep-20	Unenhanced	5	130.0	3	2.3	0	3	0	0	**3**
ALE-MT09	20-Sep-20	Enhanced	5	131.5	9	6.8	1	6	1	0	**8**
ALE-MT05	20-Sep-20	Enhanced	5	131.3	1	0.8	0	0	0	0	**0**
ALE-MT06	20-Sep-20	Unenhanced	10	245.0	18	7.3	1	6	4	3	**14**
Total:			**44**	**1,076.2**	**49**	**4.6**	**2**	**30**	**8**	**3**	**43**
Average:			**5.5**	**134.5**	**6**	**4.2**	**0**	**4**	**1**	**0**	**5**
Standard Deviation:				**46.2**	**5**	**2.3**	**0**	**2**	**1**	**1**	**4**

[1] Includes all captured fish in the minnow traps

[2] Only includes fish measured for fork length and assigned an age.

Table 10. **Summary of fork length, weight, and condition for juvenile Cutthroat Trout captured in Alena Creek in 2020.**

Age Class	Fork Length (mm)				Weight (g)				Condition Factor (K)			
	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Fry (0+)	1	55	55	55	1	1.9	1.9	1.9	2	1.14	1.14	1.14
Parr (1+)	19	90	74	113	18	7.7	4.1	14.1	30	0.98	0.82	1.21
Parr (2+)	7	126	119	140	7	19.3	15.3	27.3	0	0.95	0.87	1.00
Adult (≥3+)	3	156	150	160	3	34.4	32.0	36.7	1	0.91	0.89	0.95
All	**30**	**104**	**55**	**160**	**29**	**13.0**	**1.9**	**36.7**	**43**	**0.97**	**0.82**	**1.21**

Table 11. **Size bins by age class for juvenile Cutthroat Trout captured in Alena Creek in 2020.**

Age Class	Fork Length Range (mm)
Fry (0+)	≤55
Parr (1+)	70-113
Parr (2+)	119-140
Adult (≥3+)	≥150

Figure 20. **Fork length frequency for juvenile Cutthroat Trout captured (by minnow trapping) in Alena Creek in 2020.**

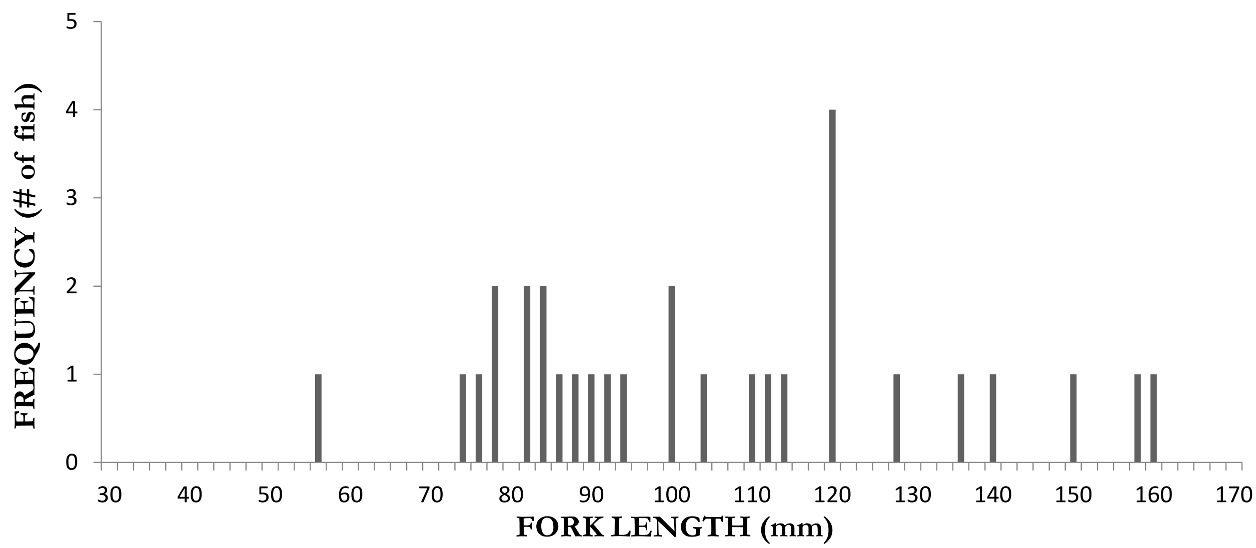
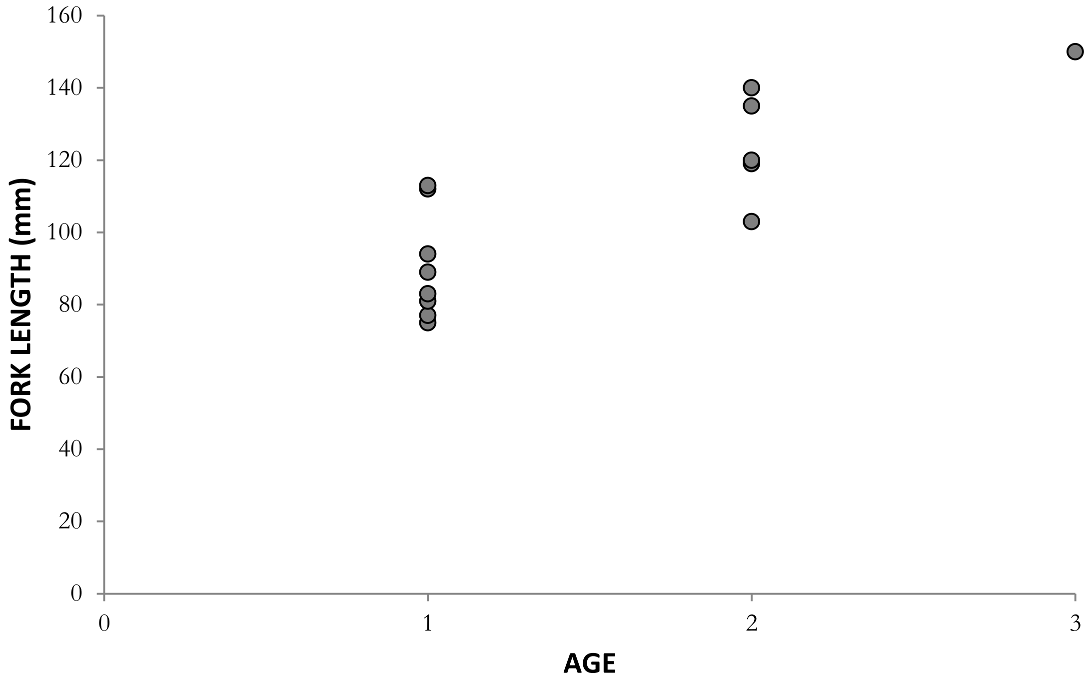


Figure 21. Fork length by age for juvenile Cutthroat Trout captured in Alena Creek in 2020.



4.2.2.3. Coho Salmon

A total of 932 juvenile Coho Salmon were captured during minnow trap sampling in Alena Creek on September 20, 2020 (Table 12). CPUE ranged from 22.1 fish per 100 trap hours at ALE-MT02 (enhanced) to 156.2 fish per 100 trap hours in ALE-MT05 (enhanced) (Table 12). The total average CPUE was 76.6 fish per 100 trap hours (± 50.2 SD) (Table 12). Summary statistics of fish length, weight, and condition factor are presented for each age class in Table 13. Discrete fork length ranges were defined for each age class (Table 13), based on a review of the length-frequency histogram (Figure 22) and aging data from scale analysis (Figure 23).

Coho Salmon Fry (0+)

Coho Salmon fry (0+) were captured at all sampling sites in 2020 and are distributed throughout the sampled reaches of Alena Creek (Table 12). Due to the large volume of Coho Salmon juveniles captured, not all fish were measured for fork length and therefore not all Coho Salmon could be assigned an age class. Based on total captures, we have assumed that Coho fry were most abundant at ALE-MT06 and ALE-MT08 in the unenhanced reach (Reach 2) and ALE-MT05 in the enhanced reach (Reach 3).

Coho Salmon Parr (1+)

Coho Salmon 1+ parr were captured at all sites in 2020 (Table 12). Based on total captures, 1+ parr were likely most abundant at ALE-MT06 and ALE-MT08 in the unenhanced reach (Reach 4).

Table 12. Catch and CPUE for Coho Salmon captured in Alena Creek in 2020.

Site	Date	Enhancement Status	# of Traps	Total Soak Time (hrs)	Total CO Catch (# of Fish)[1]	CPUE (# of Fish/100 Trap hrs) [1]	Measured CO Catch (# of Fish)[2]		
							0+	1+	All
ALE-MT01	20-Sep-20	Enhanced	5	110.4	30	27.2	19	11	**30**
ALE-MT02	20-Sep-20	Enhanced	5	113.3	25	22.1	20	5	**25**
ALE-MT07	20-Sep-20	Enhanced	5	117.8	54	45.9	40	14	**54**
ALE-MT03	20-Sep-20	Unenhanced	4	97.0	57	58.8	30	13	**43**
ALE-MT08	20-Sep-20	Unenhanced	5	130.0	104	80.0	58	46	**104**
ALE-MT09	20-Sep-20	Enhanced	5	131.5	103	78.3	24	11	**35**
ALE-MT05	20-Sep-20	Enhanced	5	131.3	205	156.2	23	39	**62**
ALE-MT06	20-Sep-20	Unenhanced	10	245.0	354	144.5	65	71	**136**
Total:			**44**	**1,076.2**	**932**	**86.6**	**279**	**210**	**489**
Average:			**5.5**	**134.5**	**117**	**76.6**	**35**	**26**	**61**
Grand Standard Deviation:				**46.2**	**112**	**50.2**	**18**	**23**	**39**

[1] Includes all captured fish in the minnow traps

[2] Only includes fish measured for fork length and assigned an age.

Table 13. Summary of fork length, weight, and condition for Coho Salmon captured in Alena Creek in 2020.

Age Class	Fork Length (mm)				Weight (g)				Condition Factor (K)			
	n	Average	Min	Max	n	Average	Min	Max	n	Average	Min	Max
Fry (0+)	165	55	41	70	160	2.2	0.8	4.6	279	1.24	0.63	2.26
Parr (1+)	89	82	73	105	88	6.6	4.2	11.5	210	1.16	0.98	1.59
All	**254**	**65**	**41**	**105**	**248**	**3.7**	**0.8**	**11.5**	**489**	**1.21**	**0.63**	**2.26**

Table 14. Size bins by age class for Coho Salmon captured in Alena Creek in 2020.

Age Class	Fork Length Range (mm)
Fry (0+)	41-70
Parr (1+)	73-105

Figure 22. Fork length frequency for juvenile Coho Salmon captured (minnow trapping) in Alena Creek in 2020.

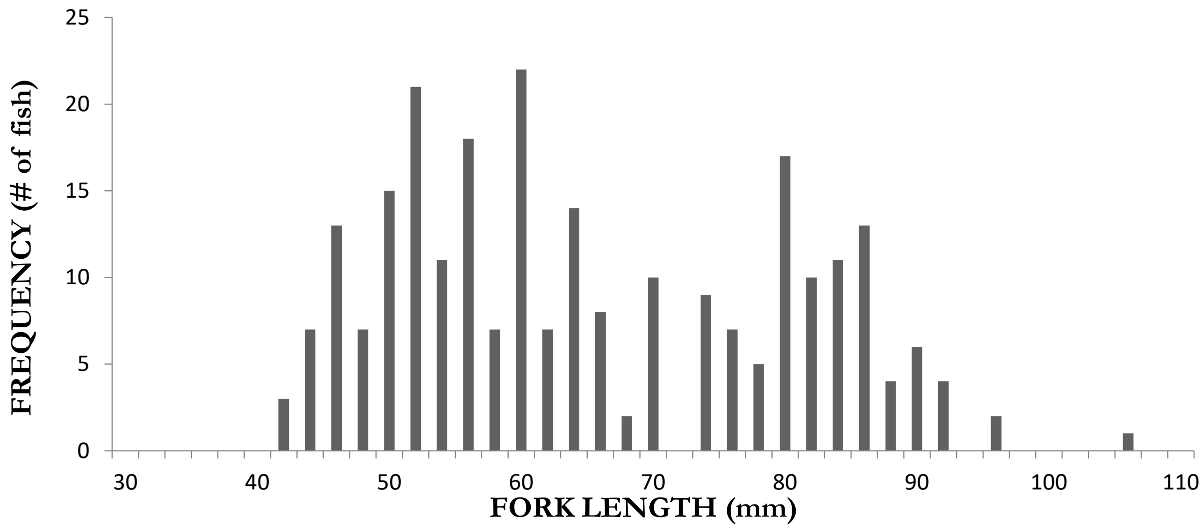
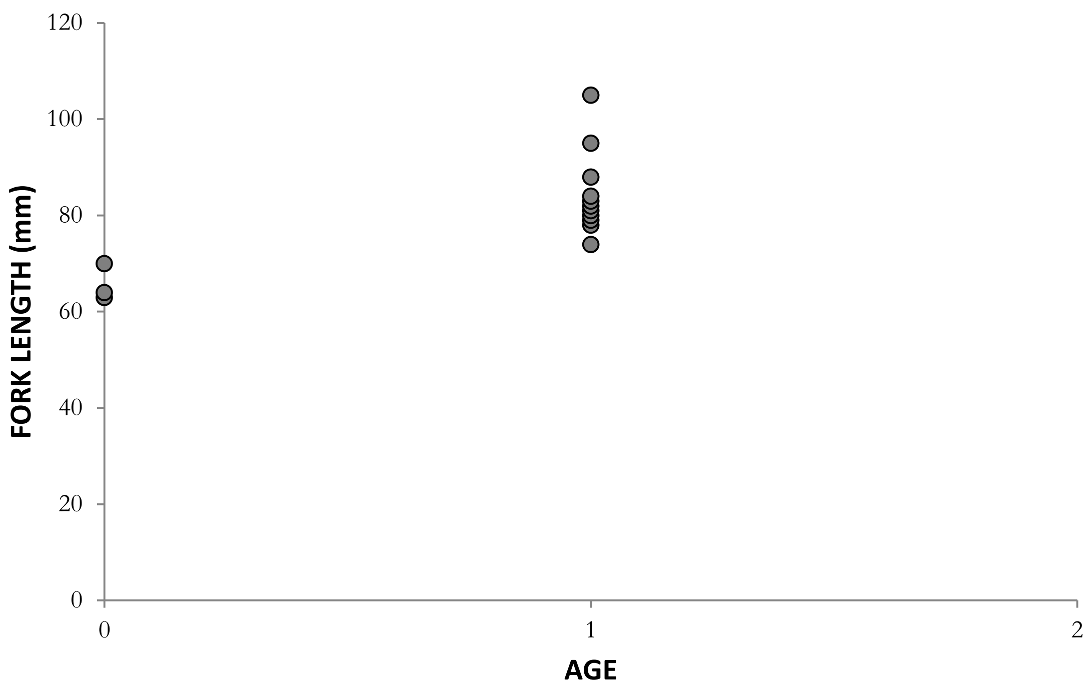


Figure 23. Fork length by age for Coho Salmon captured in Alena Creek in 2020.



4.2.2.4. Bull Trout

No Bull Trout were captured in Alena Creek minnow traps in 2020.

4.2.2.5. Comparison Among Years

Cutthroat Trout

The average Cutthroat Trout CPUE in 2020 (4.1 fish per 100 trap hours) was higher than in all previous sampling years except 2014 (Figure 24), when the average CPUE was 7.2 fish per 100 trap hours. The 2014 CPUE results are, however, biased high because the minnow traps were left only during the daytime in this year (due to bear activity) and soak times were therefore shorter than in other years (Harwood *et. al.* 2016). Given that catchability is not likely constant throughout the trap soak time, and that there is likely a high initial catch rate that diminishes over time (Harwood *et al.* 2016), a shorter soak time would result in an apparent higher CPUE. Between 2018 and 2020 there were more sites sampled than in previous years (eight sites versus six sites), although this should not affect comparability of CPUE among years since it is a standardized metric.

In 2020, Cutthroat Trout were relatively evenly distributed in relatively low numbers throughout Alena Creek; exceptions were at ALE-MT06 (unenhanced) and ALE-MT09 (enhanced), where CPUE was 7.3 and 6.8 fish per 100 trap hours, respectively (Figure 25). CPUE at remaining sites ranged from 0.8 to 5.2 fish per 100 trap hours. These captures were higher than in previous years.

In all sampling years, the most abundant age class of Cutthroat Trout captured was 1+ parr. Two fry were captured in 2020, whereas three fry were captured in 2019 and zero were captured in 2017 and 2018 (Table 9).

Figure 24. Comparison of minnow trap CPUE for Cutthroat Trout during baseline (2013 and 2014) and post-construction (2017-2020) sampling. Error bars represent standard error. Note that 2014 CPUE may be an overestimation due to shorter soak time at some sites due to bear activity.

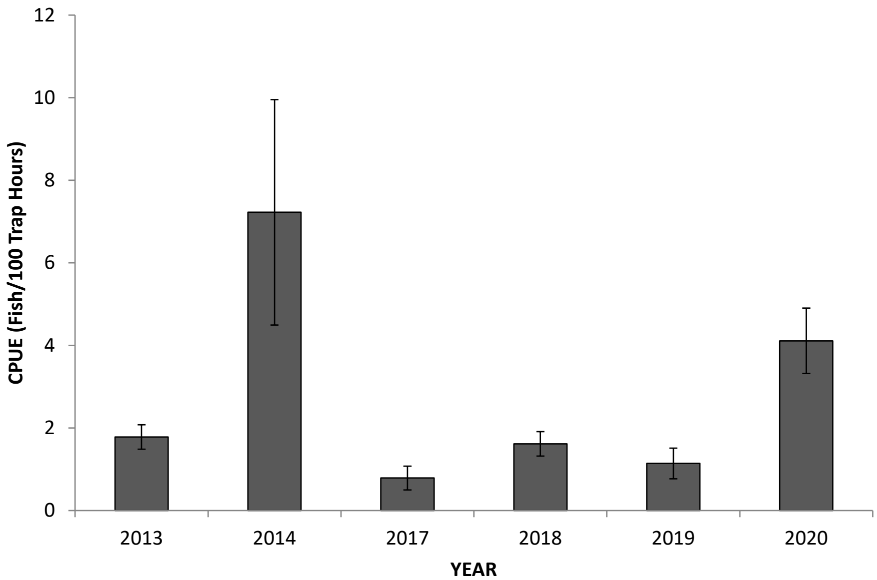
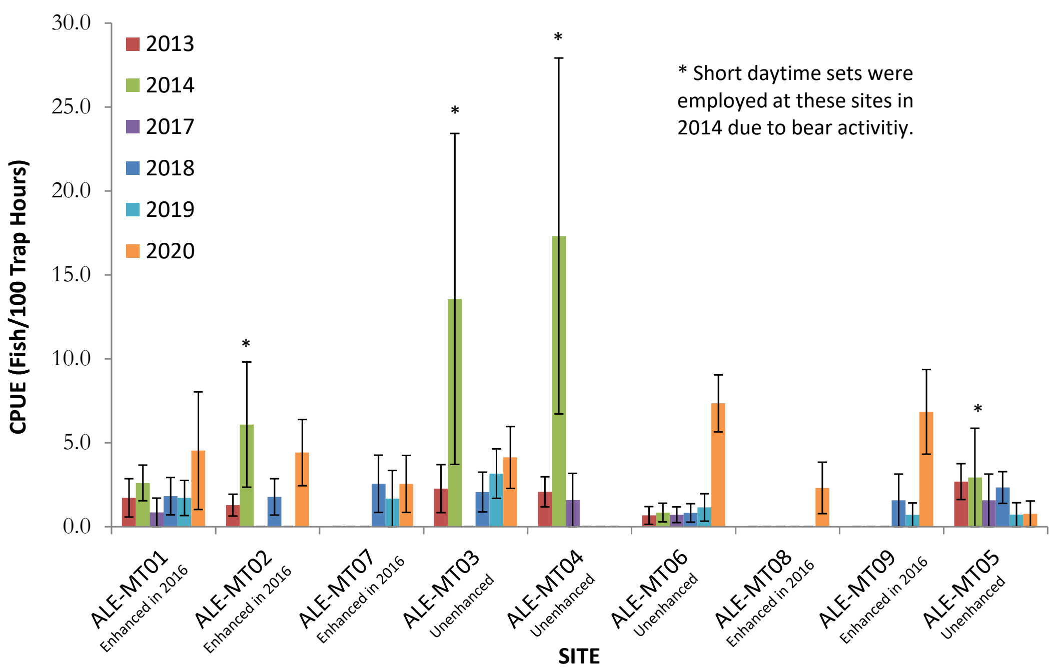


Figure 25. Comparison of minnow trap CPUE for Cutthroat Trout at each site during baseline (2013 and 2014) and post-construction (2017-2020) sampling. Error bars represent standard error.



Coho Salmon

The average Coho Salmon CPUE in 2020 was 75.1 fish per 100 trap hours, which was similar to the CPUE in 2018 and higher than the CPUE in 2019 (33.3 and 83.8 fish were captured per 100 trap hours in 2019 and 2018, respectively; Figure 26). CPUE was higher in 2020 and 2018 than baseline, considering that the 2014 CPUE results are biased high by the short daytime sets (as described for Cutthroat Trout above). Between 2018 and 2020 there were more sites sampled than in previous years (eight sites versus six sites), although this should not directly affect comparability of CPUE among years since it is a standardized metric.

In 2020, Coho Salmon fry and parr were captured at all sites. CPUE of Coho Salmon at individual sites in 2020 was generally similar to that in previous years of sampling, with the exception of ALE-MT05 (unenhanced) and ALE-MT06 (unenhanced), where CPUE was notably higher in 2020 than in previous years (Figure 27).

Figure 26. Comparison of minnow trap CPUE for Coho Salmon during baseline (2013 and 2014) and post-construction (2017-2020) sampling. Error bars represent standard error. Note that 2014 CPUE may be an overestimation due to shorter soak time at some sites due to bear activity.

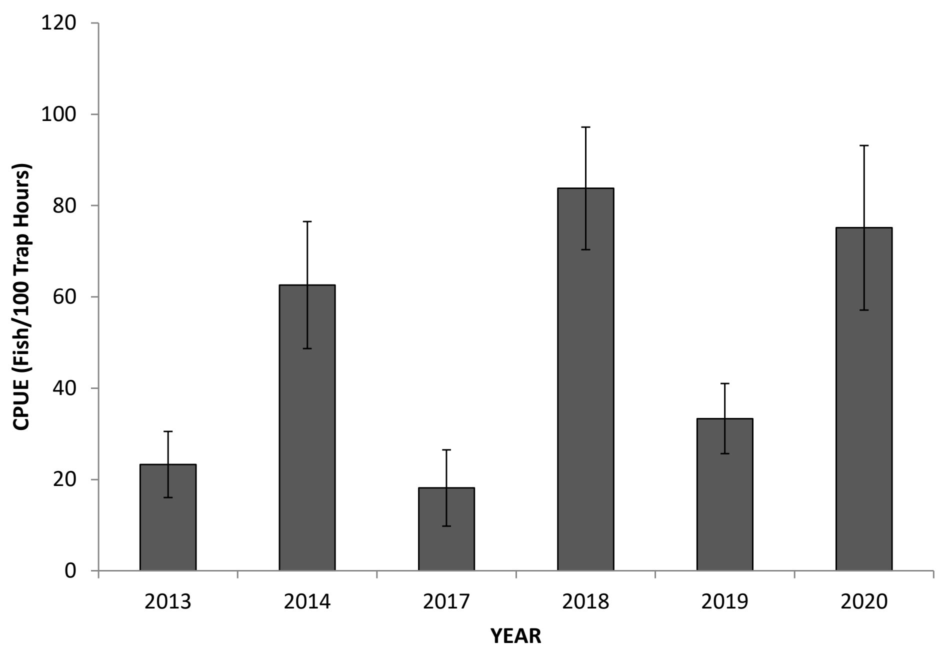
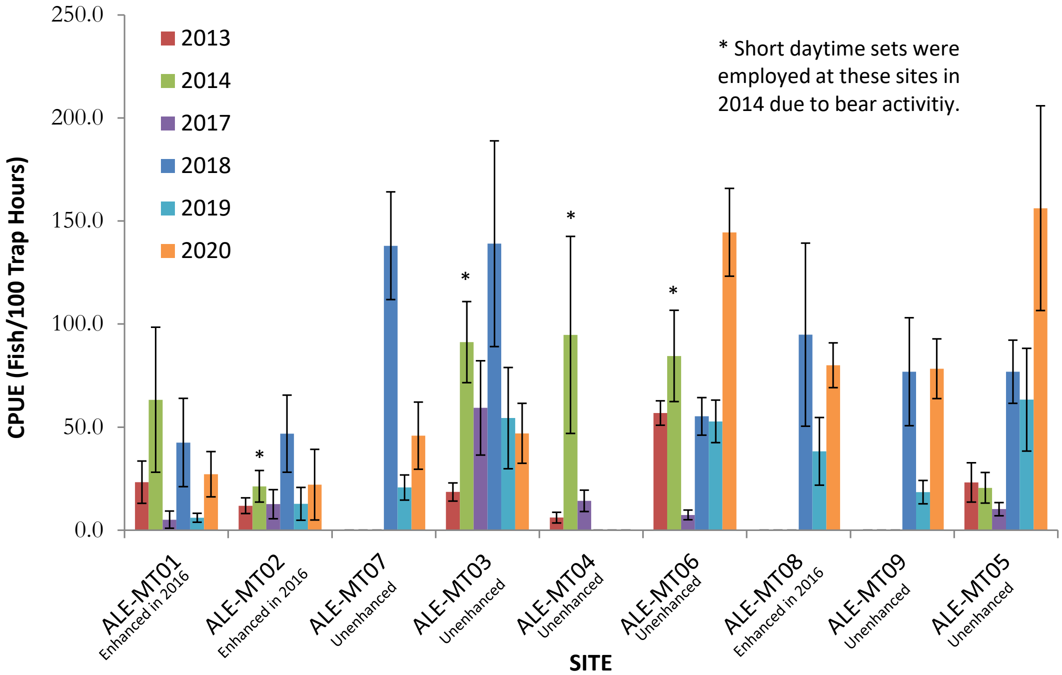


Figure 27. Comparison of minnow trap CPUE for Coho Salmon at each site during baseline (2013 and 2014) and post-construction (2017-2020) sampling. Error bars represent standard error.

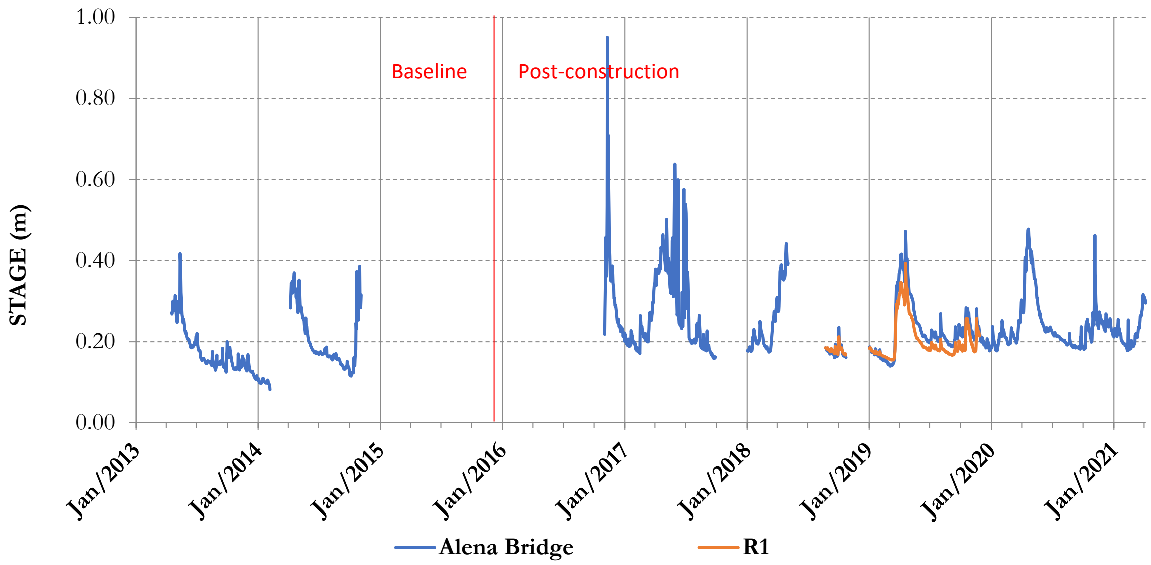


4.3. Hydrology

Seasonal trends in the Alena Creek hydrograph in 2020 were consistent with a coastal, snow-dominated watershed. Seasonal hydrograph patterns remained broadly consistent with observations from baseline and post-construction monitoring. Stage readings in 2020 remained relatively low throughout the winter (i.e., January 2020 to mid-March) when precipitation was snow dominated, then increased during snow melt in spring (March and April). Stage remained low during monitoring in late-summer and early fall (August 23 to October) when precipitation was minimal (Figure 28). A spike in stage occurred in late October 2020.

In 2020, overall mean daily stage at Alena bridge was 0.24 ± 0.06 m. The daily maximum stage in 2020 was recorded on April 21, 2020 (0.48 m), corresponding with spring snowmelt. This was less than the maximum stage measured since records began in May 2013, which was recorded on November 9, 2016 (0.95 m) during a 1-in-20-year return flood event on the Upper Lillooet River (McCoy, pers. comm. 2016), but was consistent with peak values recorded during baseline monitoring (Figure 28). In addition to the peak in April 2020, stage spiked in early November 2020 (0.46 m). The minimum stage in 2020 occurred on January 17, 2020 (0.18 m). This minimum value is higher than the lowest stage recorded since records began (0.08 m on February 5, 2014), and higher than the lowest stage recorded in post-construction years (0.14 m on March 4, 2019).

Figure 28. Stage in Alena Creek at the Lillooet River FSR bridge during baseline (April 2013 to November 2014), and post-construction monitoring (November 2016 to March 2021).



4.4. Water Temperature

4.4.1. Overview

The results of the pre-construction and post-construction water temperature metrics, including Year 4 (2020) data, are summarized in the following sections. Water temperature site photos are presented in Appendix B and annual water temperature figures and BC WQG for water temperature are presented in Appendix C. This report is a data summary report; thus, any changes in water temperature related to the construction of the FHEP will be evaluated with a BACI analysis following five years of post-construction water temperature data collection.

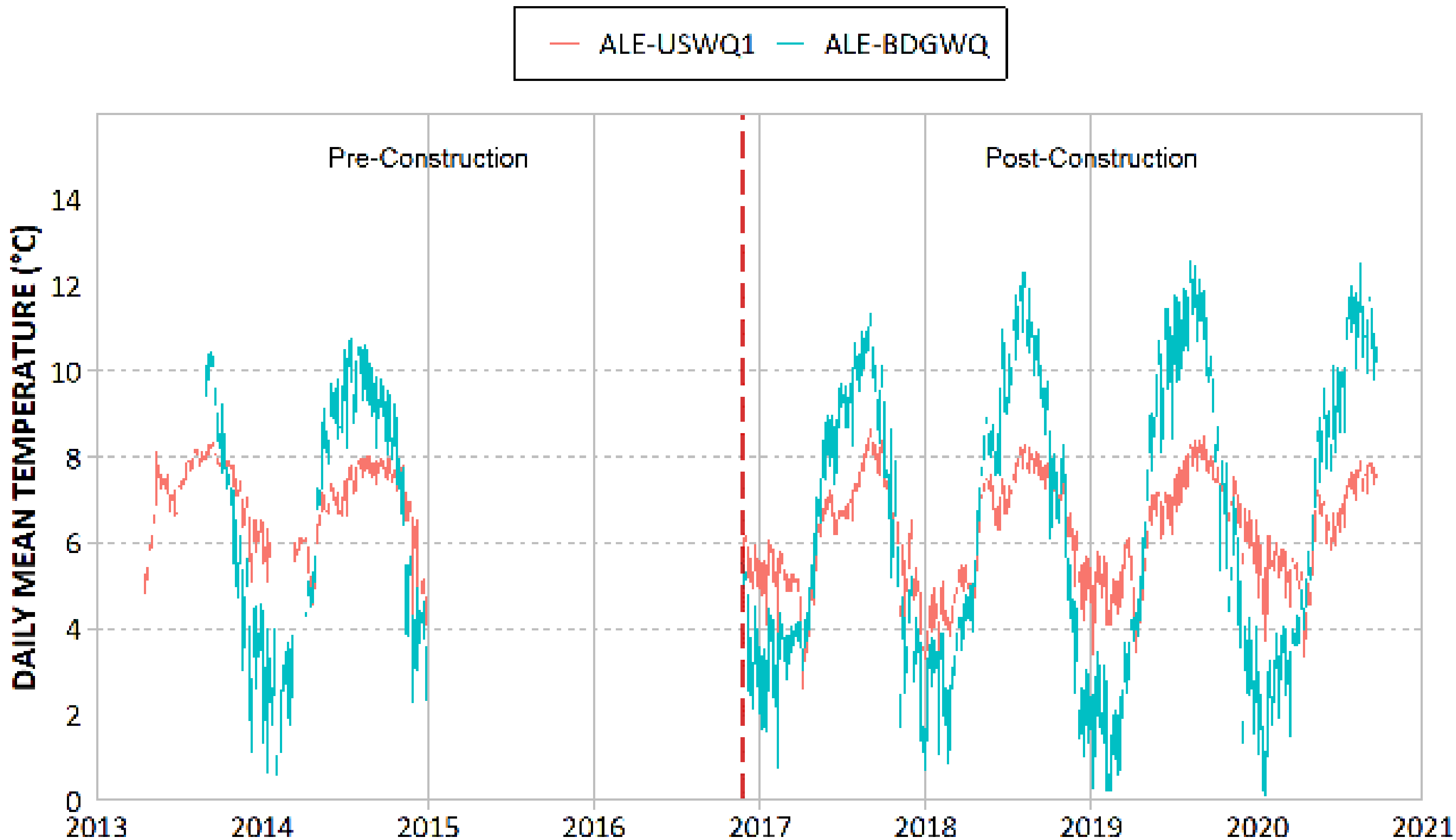
Monitoring in Years 1, 2, 3, and 4 (2017, 2018, 2019, 2020) complete nearly four full years of post-construction water temperature data collection at the upstream (control; ALE-USWQ1) and downstream (impact; ALE-BDGWQ) sites. The post-construction period of record is from November 23, 2016 to September 21, 2020 (Table 1, Map 2). Data availability is based on the most recent download of water temperature loggers.

Daily average, maximum, and minimum water temperature at ALE-USWQ1 and ALE-BDGWQ are shown in Figure 29. The pattern of differences in water temperature between the two sites during the winter and summer seasons is largely the same pre- and post-construction, as evident in the differences in the cumulative frequency distribution between the sites (Figure 30). Despite the small difference in elevation (11 m) and short distance (~1 km) between the sites, the downstream site has generally been warmer than the upstream site in the summer and cooler in the winter (Figure 29, Figure 30). It is thought that this is in part due to the temperature-regulating influence of groundwater at the upstream site, and to a tributary that enters Alena Creek between the two sites, which may account for some of the cooler temperatures downstream in the winter and warmer temperatures downstream in the summer (Figure 29, Figure 30, Map 2).

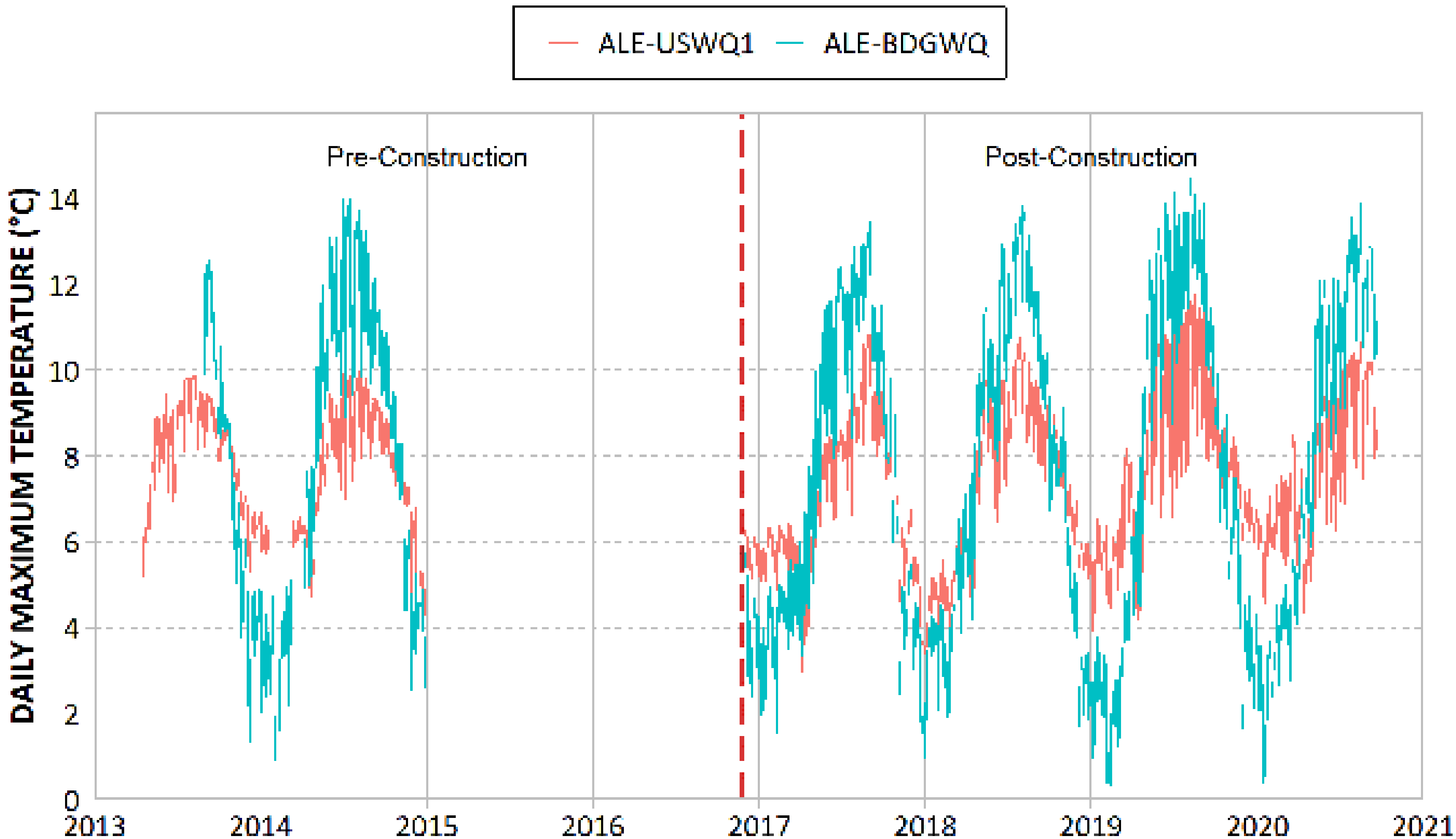
In general, water temperature upstream (ALE-USWQ1) varied over a narrower range than observed downstream (ALE-BDGWQ) (Figure 29). The daily average temperatures recorded at both sites were higher post-construction (2017-2020) than pre-construction (2013-2014) in the warmer months and the increase is more pronounced at the downstream site. Trends in the data attributable to the FHEP will be evaluated following five years of data collection through a BACI analysis.

Figure 29. **Overall average (a), maximum (b), and minimum (c) temperature in Alena Creek pre-construction (2014 to 2015) and post-construction (2017 to 2020) recorded at the upstream control (ALE-USWQ1) and downstream impact (ALE-BDGWQ) sites.**

(a) Daily Average



(b) Daily Maximum



(c) Daily Minimum

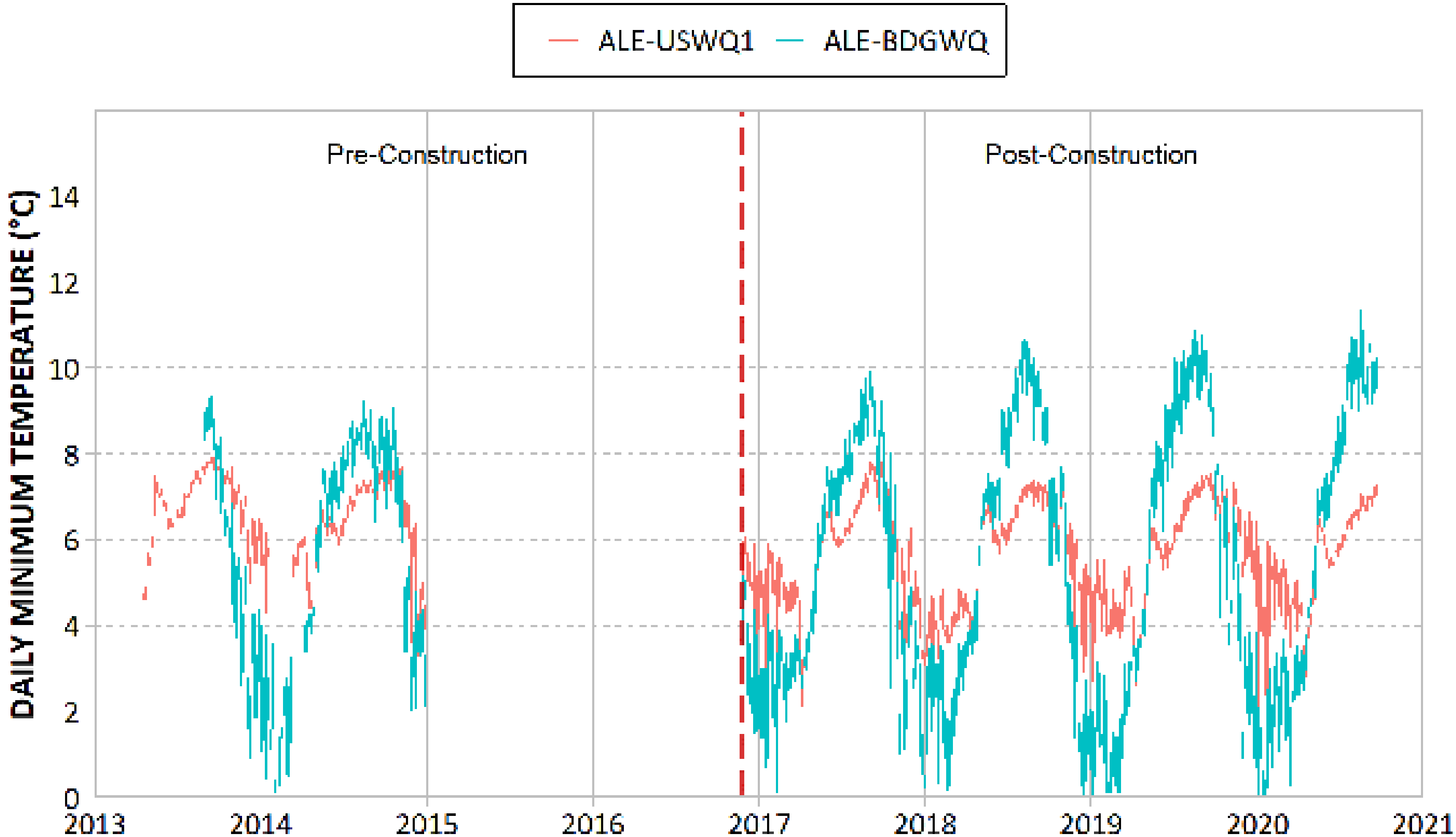
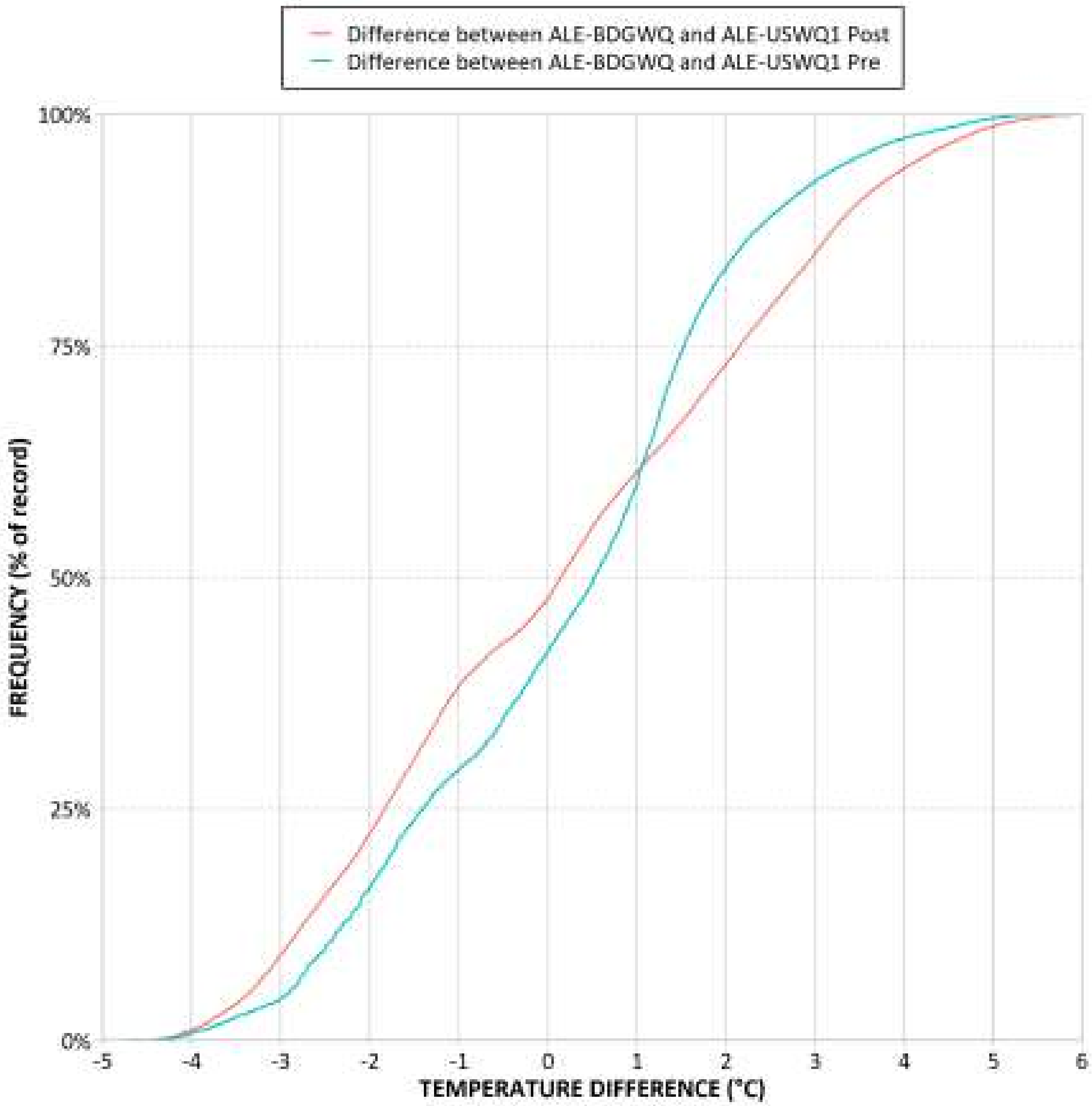


Figure 30. Cumulative frequency distribution of differences in pre-construction (2013 2014) and post-construction (2016-2020) instantaneous water temperature between the downstream site (ALE-BDGWQ) and the upstream site (ALE USWQ1) (positive values indicate warmer temperatures at ALE-BDGWQ).



4.4.2. Monthly Summary Statistics

The mean, instantaneous minimum, instantaneous maximum, and standard deviation for water temperature for each month of the record are summarized for the pre-construction period in Table 15 and for the post-construction period in Table 16 and Table 17. The minimum and maximum monthly average and instantaneous water temperatures are highlighted for each monitoring period (pre-construction and post-construction). Overall, at the upstream site, no substantial change in monthly average water temperature statistics has been observed in Year 4 (5.4°C to 7.5°C; Table 17) in comparison to monthly average temperature pre-construction (5.0°C in December 2014 to 8.1°C in September 2013; Table 15) and post-construction to date (4.0°C in April 2017 to 8.1°C to August 2019; Table 16). No data are available for January, February, or March 2014 pre-construction at the upstream site, therefore the monthly average minimum of 5.0°C measured in December 2014 may not be representative of the coolest monthly average pre-construction.

At the downstream site monthly average temperatures ranged from 2.2°C to 10.1°C pre-construction (Table 15), and from 1.2°C (February 2019) to 11.7°C (August 2019) post-construction (Table 16, Table 17). The 2020 monthly average water temperature ranged from 1.9°C (January 2020) to 11.1°C (August 2020). To date, 2019 exhibits the highest and lowest average monthly temperatures at the downstream site.

Pre-construction minimum and maximum instantaneous temperatures ranged from 2.8°C (December 2014) to 10.0°C (July and August 2014) at the upstream site and 0.0°C (February 2014) to 14.0°C (July 2014) at the downstream site (Table 15). Post-construction (2016 to 2019), instantaneous minimum and maximum temperatures ranged from 0.8°C (February 2017) to 11.8°C (August 2019) at the upstream site and 0.0°C (January 2019) to 14.5°C (August 2019) at the downstream site (Table 16). In 2020, instantaneous temperatures were within the post-construction ranges at the upstream (1.9°C to 10.7°C) and downstream sites (0.0°C to 13.9°C) (Table 17).

Table 15. Alena Creek monthly water temperature summary statistics measured pre-construction (May 2013 to December 2014) at the upstream site (ALE USWQ1) and downstream site (ALE-BDGWQ).

Year	Month	Water Temperature (°C)							
		ALE-USWQ1				ALE-BDGWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2013	May	7.2	5.4	9.0	0.8	-	-	-	-
	Jun	7.0	6.2	9.5	0.6	-	-	-	-
	Jul	7.6	6.5	9.9	0.9	-	-	-	-
	Aug	8.0	7.3	9.9	0.6	-	-	-	-
	Sep	8.1	7.3	9.6	0.4	9.6	6.9	13.0	1.2
	Oct	7.8	6.9	8.9	0.3	7.5	4.5	10.6	1.0
	Nov	7.0	6.1	8.1	0.4	5.2	2.4	7.6	1.0
	Dec	6.1	5.0	7.1	0.5	3.4	0.9	5.5	1.1
2014	Jan	-	-	-	-	2.7	0.4	4.9	1.1
	Feb	-	-	-	-	2.2	0.0	5.0	1.2
	Mar	-	-	-	-	-	-	-	-
	Apr	5.4	4.4	6.4	0.6	5.0	3.4	9.6	1.1
	May	6.7	5.3	8.9	0.6	7.9	5.3	12.0	1.4
	Jun	7.0	5.9	9.5	0.8	9.1	6.4	13.1	1.6
	Jul	7.4	6.3	10.0	0.9	9.9	7.4	14.0	1.7
	Aug	7.9	7.1	10.0	0.7	10.1	7.9	13.8	1.4
	Sep	7.7	6.6	9.4	0.5	9.2	6.4	12.2	1.1
	Oct	7.6	6.9	8.9	0.3	8.4	6.7	10.9	0.8
	Nov	6.9	3.6	8.0	0.9	5.4	2.0	8.3	1.6
	Dec	5.0	2.8	6.8	0.9	3.9	2.1	5.3	0.7

Monthly statistics were not generated for months with less than three weeks of data.

Monthly average and instantaneous maximum (red shading) and minimum (blue shading) are highlighted for the monitoring period.

Table 16. Alena Creek monthly water temperature summary statistics measured post-construction (December 2016 to September 2019) at the upstream site (ALE USWQ1) and downstream site (ALE-BDGWQ).

Year	Month	Water Temperature (°C)							
		ALE-USWQ1				ALE-BDGWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2016	Dec	5.5	2.5	6.3	0.4	3.5	1.5	5.7	0.9
2017	Jan	5.4	2.0	6.4	0.5	3.2	0.7	5.0	1.0
	Feb	5.3	0.8	6.4	0.5	3.2	0.1	5.1	0.9
	Mar	5.1	4.3	6.5	0.3	3.8	2.5	6.0	0.6
	Apr	4.0	2.1	6.4	0.9	4.3	2.5	8.3	1.1
	May	6.4	4.5	8.3	0.7	7.3	4.3	11.5	1.4
	Jun	6.7	5.8	8.5	0.6	8.5	6.5	12.3	1.4
	Jul	6.9	5.9	9.5	0.8	9.5	7.3	12.9	1.4
	Aug	7.9	6.6	10.8	0.9	10.4	8.1	13.2	1.3
	Sep	8.1	6.7	10.8	0.7	9.7	6.8	13.5	1.1
	Oct	6.9	3.8	8.8	0.8	6.9	2.5	9.8	1.2
	Nov	5.4	3.3	7.1	0.8	3.8	1.0	6.6	1.2
	Dec	4.6	3.1	6.6	0.9	2.8	0.2	5.3	1.3
2018	Jan	4.2	3.2	5.2	0.5	2.9	0.4	4.3	0.9
	Feb	4.3	3.6	5.6	0.4	2.5	0.1	4.5	1.1
	Mar	5.0	3.8	6.8	0.6	3.8	1.0	7.1	1.0
	Apr	5.1	3.4	8.5	1.0	5.2	2.4	9.9	1.4
	May	7.3	5.5	9.8	0.8	8.3	5.4	11.5	1.3
	Jun	6.9	5.7	9.8	0.8	9.0	6.4	12.9	1.5
	Jul	7.6	5.9	10.8	1.1	10.8	7.7	13.6	1.4
	Aug	8.0	6.8	10.4	0.8	11.1	8.3	13.9	1.1
	Sep	7.6	6.7	9.8	0.6	9.7	7.4	11.9	0.8
	Oct	7.2	5.6	9.0	0.6	7.2	5.0	8.8	0.8
	Nov	6.4	3.9	8.4	0.6	5.2	1.4	9.1	1.4
	Dec	5.2	2.9	6.8	0.6	2.1	0.1	4.8	0.9
2019	Jan	5.1	2.7	6.6	0.6	2.2	0.0	3.8	0.8
	Feb	4.6	3.8	6.4	0.6	1.2	0.1	3.2	0.8
	Mar	5.4	3.7	8.2	0.9	2.8	0.1	5.9	1.1
	Apr	4.5	2.6	7.7	0.9	4.8	2.7	9.6	1.4
	May	6.7	4.8	10.7	1.2	8.8	4.4	13.3	2.0
	Jun	6.8	5.3	10.8	1.2	10.0	6.2	13.9	1.6
	Jul	7.4	5.9	11.3	1.2	10.9	8.4	14.2	1.3
	Aug	8.1	6.7	11.8	1.2	11.7	9.2	14.5	1.2
	Sep	7.9	6.5	11.5	0.8	10.2	6.6	13.9	1.2
	Oct	7.2	5.5	9.5	0.6	7.0	3.6	9.9	1.3
	Nov	6.8	5.2	8.5	0.6	5.1	0.9	7.5	1.6
	Dec	6.2	4.4	7.2	0.5	3.0	0.7	4.8	0.9

Monthly statistics were not generated for months with less than three weeks of data.

Monthly average and instantaneous maximum (red shading) and minimum (blue shading) are highlighted for the monitoring period.

Post construction water temperature monitoring commenced on November 23, 2016.

Table 17. Alena Creek monthly water temperature summary statistics measured post-construction (January 2020 to August 2020) at the upstream site (ALE USWQ1) and downstream site (ALE-BDGWQ).

Year	Month	Water Temperature (°C)							
		ALE-USWQ1				ALE-BDGWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2020	Jan	5.4	1.9	7.1	0.9	1.9	0.0	3.9	1.1
	Feb	5.6	4.1	7.6	0.5	3.0	0.7	4.7	0.8
	Mar	5.4	3.5	8.5	0.9	3.4	0.3	6.4	1.0
	Apr	4.6	2.6	7.7	0.9	4.8	2.4	8.4	1.3
	May	6.6	4.5	9.4	0.9	8.0	4.6	12.1	1.7
	Jun	6.3	5.3	9.8	0.9	8.9	6.5	12.1	1.3
	Jul	7.1	5.8	10.4	1.1	10.5	7.8	13.6	1.4
	Aug	7.5	6.4	10.7	1.0	11.1	9.0	13.9	1.0
	Sep	-	-	-	-	-	-	-	-

Monthly statistics were not generated for months with less than three weeks of data.
Post construction water temperature monitoring commenced on November 23, 2016.
Monthly average and instantaneous maximum (red shading) and minimum (blue shading) are highlighted for the monitoring period, after a full year of monitoring data are available.

4.4.3. Growing Season Degree Days

The fall and early winter (October to December 31) weekly and maximum average temperatures upstream of the FHEP area have been relatively mild, remaining above 4°C during the pre- and post-construction monitoring periods (Figure 29). Therefore, the growing season end date for Alena Creek was calculated based on weekly average temperatures reaching 5°C rather than 4°C (see Section 3.4.1).

The start of the growing season based on the water temperature record at each site is consistently observed at the middle to end of April both pre- and post-construction (Table 18). The growing season end dates were more variable upstream ranging from early November (post-construction) to late December (pre-construction and post-construction). At the downstream site, the growing season end dates were in mid-November pre-construction and late October to mid-November post-construction.

Considering both sites, which define the downstream and upstream extent of the FHEP, the growing season varied from 1,634 to 1,836 degree days pre-construction and from 1,346 to 1,872 degree days post-construction (Table 18).

Table 18. Growing season length and degree days upstream and downstream of the FHEP in Alena Creek pre- and post-construction (2013-2020) as determined from water temperature monitoring at the upstream site (ALE USWQ1) and downstream site (ALE-BDGWQ).

Site	Project Phase	Year	No. of days with valid data	Growing Season Data Summary				
				Start Date	End Date	Length (day)	Data Gap (day)	Degree Days
Upstream (ALE-USWQ1)	Pre-construction	2013	256	20-Apr	28-Dec	253	1	1,836
		2014	305	27-Apr	9-Dec	227	1	1,634
	Post-construction	2017	364	28-Apr	4-Nov	191	0	1,346
		2018	365	20-Apr	10-Dec	235	0	1,670
		2019	364	22-Apr	28-Dec	251	0	1,769
		2020	264	28-Apr	-	-	-	-
Downstream (ALE-BDGWQ)	Pre-construction[1]	2013	125	-	17-Nov	-	-	-
		2014	328	23-Apr	12-Nov	205	0	1,796
	Post-construction	2017	364	23-Apr	1-Nov	193	0	1,644
		2018	365	17-Apr	11-Nov	209	0	1,872
		2019	365	20-Apr	29-Oct	193	0	1,843
		2020	264	18-Apr	-	-	-	-

[1]Temperature monitoring at ALE-BDGWQ began in August 2013, therefore the start date and accumulated thermal units for the 2013 growing season could not be calculated.

Degree days are accumulated thermal units.

4.1.1. Hourly Rates of Water Temperature Change

Hourly rates of change in water temperature were compared to the BC WQG, which specify that the hourly rate of water temperature change should not exceed ±1.0°C/hr (Table 19, Figure 31). Based on Ecofish's experience collecting pre-construction data on several other streams in British Columbia (file data), it is normal for a small percentage of data points to have hourly rates of water temperature change that exceed ±1.0°C/hr.

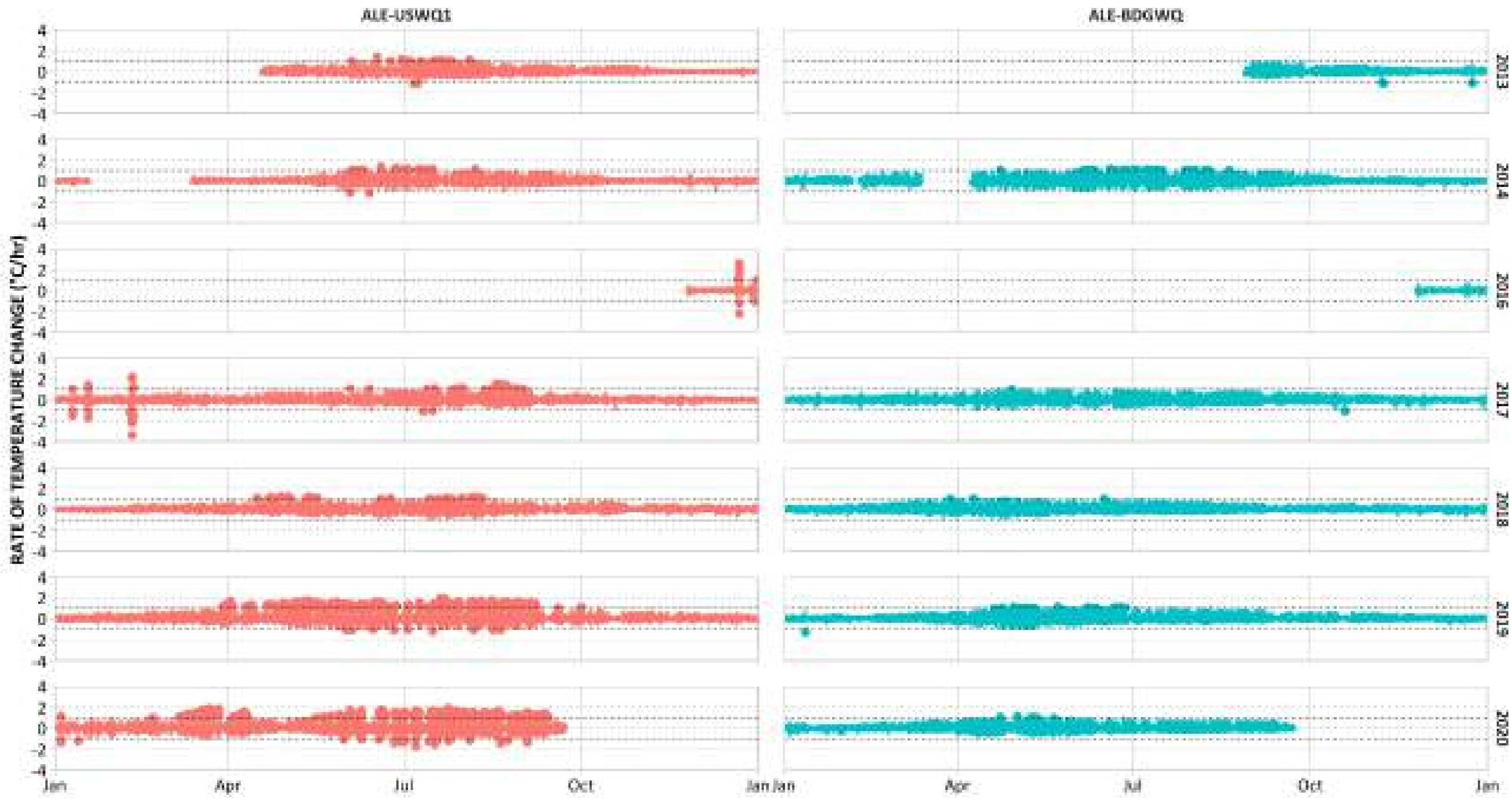
During pre- and post-construction of the FHEP, the percentage of record where exceedances were observed was low (≤1.03%). Exceedances occurred less often post-construction at the downstream site (0.06% post-construction compared to 0.23 % pre-construction); however more exceedances (1.03%) were observed at the upstream site post-construction in comparison to pre-construction (0.17%) (Table 19). The magnitude of the water temperature increase/decrease was highest during the summer months at the upstream site post-construction (Figure 31).

Table 19. Hourly rate of change (°C/hr) summary statistics and occurrence of rate of change in exceedance of ± 1.0°C/hr in Alena Creek at the upstream site (ALE USWQ1) and downstream site (ALE-BDGWQ).

Site	Project Phase	Period of Record		n	Occurrence		Max -ve	Percentile				Max+ ve
		Start Date	End Date		No.	% of Record		1st	5th	95th	99th	
ALE-USWQ1	Pre-Construction	17-Apr-13	30-Dec-14	54,395	80	0.15	-1.15	-0.44	-0.25	0.32	0.77	1.45
	Post-Construction	23-Nov-16	21-Sep-20	134,199	1386	1.03	-3.32	-0.63	-0.33	0.44	0.98	2.63
ALE-BDGWQ	Pre-Construction	27-Aug-13	30-Dec-14	44,075	102	0.23	-1.15	-0.61	-0.40	0.55	0.88	1.23
	Post-Construction	23-Nov-16	21-Sep-20	134,174	83	0.06	-1.28	-0.52	-0.33	0.52	0.78	1.17

n = number of datapoints.

Figure 31. Hourly rate of water temperature change (°C/hr) for each year pre-construction (2013 and 2014) and post-construction (2016 to 2020) in Alena Creek at the upstream site (ALE USWQ1) and downstream site (ALE-BDGWQ).



4.4.5. Daily Temperature Extremes

Alena Creek is a cool stream with no days with average water temperatures >18°C observed in either pre- or post-construction conditions (Table 20). Considering all sites and dates, the maximum monthly water temperature was 14.0°C pre-construction (July 2014) and 14.5°C post-construction (August 2019), both of which occurred at the downstream site (Table 15, Table 16).

At the upstream site, there were no days when the daily average temperature was <1°C pre- or post-construction. In contrast, at the downstream site, daily average temperatures were <1°C on one day pre-construction (2014) and from three to 19 days post-construction (2017-2020). The coolest temperatures measured to date at the downstream site were observed in 2019.

Table 20. Summary of daily average water temperature extremes (number of days >18°C and <1°C) in Alena Creek at ALE-USWQ1 and ALE-BDGWQ.

Site	Project Phase	Year[1]	n (days)	Days T_{water} > 18°C	Days T_{water} < 1°C
ALE-USWQ1	Pre-construction	2013	256	0	0
		2014	305	0	0
	Post-construction	2016	38	-	-
		2017	364	0	0
		2018	365	0	0
		2019	364	0	0
		2020	264	0	0
ALE-BDGWQ	Pre-construction	2013	125	0	0
		2014	328	0	1
	Post-construction	2016	38	-	-
		2017	364	0	3
		2018	365	0	5
		2019	365	0	19
		2020	264	0	8

n is the number of days that have observations for at least 23 hours.

[1] Data gaps occurred in the February 2014 dataset due to suspected ice conditions in the river.

A dash "-" indicates that there were not enough data to calculate the metric.

4.4.6. Mean Weekly Maximum Temperatures (MWMxT)

A comparison of MWMxT temperature data collected at the upstream site and the downstream site to optimum temperature ranges for Coho Salmon (Table 21, Table 22), Cutthroat Trout (Table 23, Table 24), and Bull Trout (Table 25, Table 26) was completed using pre- and post-construction data.

Each of the tables provides the percent complete of the data record for each life stage along with the minimum and maximum MWMxT range in each period. The percentage of data within each optimum temperature range is provided to evaluate the overall suitability of the temperate range for each fish species life stage. Exceedance of the BC WQG range (greater than ±1°C outside the optimum ranges) are highlighted in each summary table (blue indicates MWMxTs are cooler than the lower guideline and red indicates temperatures are higher than the upper guidelines). The year-round range in MWMxT temperature corresponds to the rearing life stage for all the fish species. In 2020, MWMxT values fell within the range observed in previous post-construction monitoring years.

At the upstream site, post-construction, MWMxT ranged from 3.5°C to 11.5°C, while pre-construction MWMxTs ranged from 4.4°C to 9.9°C (Table 21, Table 23, Table 25). During February 2014 data were not included due to icing concerns, therefore the minimum MWMxT value may not be representative of the pre-construction period. In 2019, the highest MWMxT value of 11.5°C was recorded.

At the downstream site, post-construction, MWMxT ranged from 0.6°C to 14.0°C, while pre-construction MWMxTs ranged from 1.7°C to 13.7°C. In 2019, both the lowest and the highest MWMxT values were recorded (0.6°C to 14.0°C)(Table 22, Table 24, Table 26).

MWMxT values in relation to species-specific optimal temperature ranges differed by species and location. Bull Trout prefer cooler temperatures overall in comparison to Cutthroat Trout and Coho Salmon (Table 3), therefore fewer exceedances of the cooler temperature limits are observed for this species. In general, the exceedances of the cooler temperature limits were more prevalent at the downstream site (ALE-BDGWQ). The upstream location (ALE-USWQ) was warmer during the winter months, likely due to the influence of groundwater at this location. General trends for each species are discussed below.

4.4.6.1. Coho Salmon

During pre- and post-construction periods, at the upstream site, MWMxT values for Coho Salmon were largely within optimal temperature ranges during spawning and incubation but were sub-optimally cool on occasion during migration and rearing (blue shading in Table 21). During pre - and post-construction periods at the downstream site, exceedances of the cooler temperature limits (blue shading) were observed during all life stages, while no exceedances of the upper temperature limits were observed (Table 22).

4.4.6.2. Cutthroat Trout

During pre- and post-construction periods, at the upstream site, MWMxT values for Cutthroat Trout were sub-optimally cool on occasion during spawning, incubation, and rearing (blue shading in

Table 23). During pre- and post-construction periods at the downstream site, exceedances of the cooler temperature limits were observed during all life stages; however, exceedances were generally observed less often during incubation and occasional exceedances of the higher temperature limits (red shading) were observed during incubation and spawning (post-construction only; Table 24).

4.4.6.3. Bull Trout:

During pre- and post-construction periods, at the upstream site, MWMxT values were largely within optimal ranges with exceedances of the upper limit during incubation and occasionally during spawning (post-construction only). Occasionally, exceedances of the lower limits were observed during rearing (Table 25). During pre- and post-construction periods at the downstream site, exceedances of the cooler temperature limits were observed during all life stages; however, exceedances were observed less often during incubation (none during pre-construction) and exceedances of the higher temperature limits (red shading) were observed during incubation and spawning (Table 26).

Warmer surface waters during Bull Trout incubation at the upstream site may be partially mitigated by groundwater upwelling, which would result in lower temperature within potential redds during the warmer months (Table 25).

Cooler and warmer MWMxTs occurred in 2019 than in previous years; however in 2020 MWMXT's fell within the post-construction range. Evaluation of any increased heating or cooling attributable to the FHEP will be completed following five years of data collection. Overall, no substantial change in the range of MWMxTs were observed between pre- and post-construction phases considering natural inter-annual variability in water temperature and considering that there were data gaps during the cooler months in the pre-construction data set.

Table 21. Coho Salmon periodicity and life stage MWMxT ranges during pre-construction (2013-2014) and post-construction (2016-2020) water temperature monitoring in Alena Creek at ALE-USWQ1.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Coho Salmon (ALE-USWQ1)	Migration (Sep. 01 to Dec. 31)	7.2-15.6	122	2013	100.0	5.6	9.4	6.6	63.1	0.0
			122	2014	95.1	4.4	9.3	21.6	62.9	0.0
			122	2016	28.7	-	-	-	-	-
			122	2017	100.0	3.5	10.5	43.4	44.3	0.0
			122	2018	100.0	5.3	9.3	23.8	55.7	0.0
			122	2019	100.0	6.4	10.3	0.0	68.0	0.0
			122	2020	14.8	-	-	-	-	-
	Spawning (Oct. 15 to Jan. 01)	4.4-12.8	79	2013	100.0	5.6	8.5	0.0	100.0	0.0
			79	2014	91.1	4.4	7.9	0.0	98.6	0.0
			79	2016	45.6	-	-	-	-	-
			79	2017	100.0	3.5	7.8	0.0	84.8	0.0
			79	2018	100.0	5.2	8.6	0.0	100.0	0.0
			79	2019	100.0	6.4	8.2	0.0	100.0	0.0
			79	2020	0.0	-	-	-	-	-
	Incubation (Oct. 15 to Apr. 01)	4.0-13.0	169	2013	67.5	5.6	8.5	0.0	100.0	0.0
			169	2014	42.6	-	-	-	-	-
			169	2016	74.6	4.6	6.3	0.0	100.0	0.0
			169	2017	100.0	3.5	7.8	0.0	91.1	0.0
			169	2018	99.4	4.8	8.6	0.0	100.0	0.0
			170	2019	100.0	4.9	8.2	0.0	100.0	0.0
			169	2020	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	9.0-16.0	365	2013	70.1	5.6	9.9	35.9	23.4	0.0
			365	2014	83.0	4.4	9.7	53.5	18.5	0.0
			366	2016	9.6	-	-	-	-	-
			365	2017	99.7	3.5	10.6	70.3	11.3	0.0
			365	2018	100.0	3.5	10.4	56.7	20.8	0.0
			365	2019	99.7	4.7	11.5	54.4	27.7	0.0
			366	2020	71.6	4.9	10.3	53.4	22.5	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 22. Coho Salmon periodicity and life stage MWMxT ranges during pre-construction (2013-2014) and post-construction (2016-2020) water temperature monitoring in Alena Creek at ALE BDGWQ.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Coho Salmon (ALE-BDGWQ)	Migration (Sep. 01 to Dec. 31)	7.2-15.6	122	2013	99.2	2.1	12.5	43.0	49.6	0.0
			122	2014	96.7	3.5	11.7	39.0	59.3	0.0
			122	2016	29.5	-	-	-	-	-
			122	2017	100.0	1.6	12.9	50.0	44.3	0.0
			122	2018	100.0	2.3	11.5	43.4	54.9	0.0
			122	2019	100.0	2.6	12.8	42.6	45.1	0.0
			122	2020	13.9	-	-	-	-	-
	Spawning (Oct. 15 to Jan. 01)	4.4-12.8	79	2013	98.7	2.1	8.8	9.0	70.5	0.0
			79	2014	93.7	3.5	9.1	0.0	75.7	0.0
			79	2016	46.8	-	-	-	-	-
			79	2017	100.0	1.6	8.1	19.0	45.6	0.0
			79	2018	100.0	2.2	8.1	38.0	59.5	0.0
			79	2019	100.0	2.6	8.1	21.5	53.2	0.0
			79	2020	0.0	-	-	-	-	-
	Incubation (Oct. 15 to Apr. 01)	4.0-13.0	169	2013	83.4	1.7	8.8	15.6	48.9	0.0
			169	2014	43.8	3.5	9.1	0.0	90.5	0.0
			169	2016	75.1	2.8	5.7	1.6	58.3	0.0
			169	2017	100.0	1.6	8.1	14.2	53.3	0.0
			169	2018	100.0	0.6	8.1	50.9	38.5	0.0
			170	2019	100.0	0.6	8.1	15.9	47.6	0.0
			169	2020	0.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	9.0-16.0	365	2013	33.7	-	-	-	-	-
			365	2014	89.6	1.7	13.7	44.6	49.8	0.0
			366	2016	9.8	-	-	-	-	-
			365	2017	99.7	1.6	13.1	56.3	37.6	0.0
			365	2018	100.0	1.8	13.4	53.2	41.9	0.0
			365	2019	100.0	0.6	14.0	53.7	43.0	0.0
			366	2020	71.3	0.6	13.0	47.1	51.7	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 23. Cutthroat Trout periodicity and life stage MWMxT ranges during pre-construction (2013-2014) and post-construction (2016-2020) water temperature monitoring in Alena Creek at ALE-USWQ1.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout (ALE-USWQ1)	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2013	79.3	5.9	8.9	42.5	0.0	0.0
			92	2014	98.9	5.0	9.3	58.2	6.6	0.0
			92	2016	0.0	-	-	-	-	-
			92	2017	98.9	3.5	8.4	87.9	0.0	0.0
			92	2018	100.0	5.3	9.7	44.6	26.1	0.0
			92	2019	100.0	4.7	10.4	35.9	35.9	0.0
			92	2020	100.0	5.0	8.8	55.4	0.0	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2013	100.0	6.9	9.9	16.1	35.5	0.0
			124	2014	99.2	6.3	9.7	18.7	37.4	0.0
			124	2016	0.0	-	-	-	-	-
			124	2017	99.2	6.2	10.6	40.7	22.8	0.0
			124	2018	100.0	7.3	10.4	10.5	58.9	0.0
			124	2019	100.0	7.6	11.5	2.4	73.4	0.0
			124	2020	100.0	6.3	10.3	16.9	37.9	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2013	70.1	5.6	9.9	3.1	78.1	0.0
			365	2014	83.0	4.4	9.7	13.9	66.0	0.0
			366	2016	9.6	-	-	-	-	-
			365	2017	99.7	3.5	10.6	40.4	46.7	0.0
			365	2018	100.0	3.5	10.4	33.7	55.1	0.0
			365	2019	99.7	4.7	11.5	21.7	62.9	0.0
			366	2020	71.6	4.9	10.3	11.5	60.3	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 24. Cutthroat Trout periodicity and life stage MWMxT ranges during pre-construction (2013-2014) and post-construction (2016-2020) water temperature monitoring in Alena Creek at ALE-BDGWQ.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Cutthroat Trout (ALE-BDGWQ)	Spawning (Apr. 01 to Jul. 01)	9.0-12.0	92	2013	0.0	-	-	-	-	-
			92	2014	92.4	5.8	12.7	24.7	60.0	0.0
			92	2016	0.0	-	-	-	-	-
			92	2017	98.9	4.4	12.2	38.5	41.8	0.0
			92	2018	100.0	5.7	12.6	23.9	60.9	0.0
			92	2019	100.0	5.1	13.1	26.1	45.7	4.3
			92	2020	100.0	5.5	11.3	34.8	62.0	0.0
	Incubation (May. 01 to Sep. 01)	9.0-12.0	124	2013	2.4	-	-	-	-	-
			124	2014	99.2	8.5	13.7	0.0	61.0	13.8
			124	2016	0.0	-	-	-	-	-
			124	2017	99.2	7.5	13.1	4.1	58.5	0.8
			124	2018	100.0	8.8	13.4	0.0	59.7	12.1
			124	2019	100.0	9.8	14.0	0.0	35.5	18.5
			124	2020	100.0	7.4	13.0	1.6	65.3	0.0
	Rearing (Jan. 01 to Dec. 31)	7.0-16.0	365	2013	33.7	-	-	-	-	-
			365	2014	89.6	1.7	13.7	34.3	59.9	0.0
			366	2016	9.8	-	-	-	-	-
			365	2017	99.7	1.6	13.1	46.4	50.5	0.0
			365	2018	100.0	1.8	13.4	40.0	55.6	0.0
			365	2019	100.0	0.6	14.0	41.9	51.8	0.0
			366	2020	71.3	0.6	13.0	35.6	56.7	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 25. Bull Trout periodicity and life stage MWMxT ranges during pre-construction (2013-2014) and post-construction (2016-2020) water temperature monitoring in Alena Creek at ALE-USWQ1.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Bull Trout (ALE-USWQ1)	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2013	100.0	5.6	9.9	0.0	73.8	0.0
			130	2014	98.5	5.8	9.7	0.0	71.1	0.0
			130	2016	9.2	-	-	-	-	-
			130	2017	100.0	5.2	10.6	0.0	71.5	9.2
			130	2018	100.0	5.7	10.3	0.0	76.9	1.5
			130	2019	100.0	6.4	11.5	0.0	67.7	27.7
			130	2020	37.7	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2013	79.3	5.6	9.9	0.0	5.9	64.5
			213	2014	69.0	4.4	9.7	0.0	14.3	78.2
			213	2016	44.6	-	-	-	-	-
			213	2017	100.0	3.5	10.6	0.0	50.7	41.3
			213	2018	99.5	4.8	10.3	0.0	41.0	47.6
			214	2019	100.0	4.9	11.5	0.0	5.1	54.2
			213	2020	23.0	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2013	70.1	5.6	9.9	0.0	96.9	0.0
			365	2014	83.0	4.4	9.7	3.0	86.1	0.0
			366	2016	9.6	-	-	-	-	-
			365	2017	99.7	3.5	10.6	9.9	59.6	0.0
			365	2018	100.0	3.5	10.4	15.1	66.3	0.0
			365	2019	99.7	4.7	11.5	3.8	78.3	0.0
			366	2020	71.6	4.9	10.3	0.4	88.5	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).
[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

Table 26. Bull Trout periodicity and life stage MWMxT ranges during pre-construction (2013-2014) and post-construction (2016-2020) water temperature monitoring in Alena Creek at ALE-BDGWQ.

Species	Life Stage Data			Year	% Complete[1]	MWMxT		% of MWMxT		
	Periodicity	Optimum Temperature Range (°C)	Duration (days)			Min. (°C)	Max. (°C)	Below Lower Bound by >1°C	Within Optimum Range	Above Upper Bound by >1°C
Bull Trout (ALE-BDGWQ)	Spawning (Aug. 01 to Dec. 08)	5.0-9.0	130	2013	76.9	2.1	12.5	6.0	47.0	25.0
			130	2014	99.2	3.5	13.3	3.9	29.5	48.1
			130	2016	10.0	-	-	-	-	-
			130	2017	100.0	3.3	13.1	6.2	26.9	43.8
			130	2018	100.0	2.4	13.4	5.4	36.9	34.6
			130	2019	100.0	2.6	14.0	10.0	39.2	43.1
			130	2020	36.9	-	-	-	-	-
	Incubation (Aug. 01 to Mar. 01)	2.0-6.0	213	2013	83.1	1.7	12.5	0.0	54	36.2
			213	2014	69.5	3.5	13.3	0.0	31	67.6
			213	2016	45.1	-	-	-	-	-
			213	2017	100.0	1.6	13.1	0.0	51.6	40.8
			213	2018	100.0	0.6	13.4	3.3	45.5	46.0
			214	2019	100.0	0.6	14.0	1.9	46.7	40.7
			213	2020	22.5	-	-	-	-	-
	Rearing (Jan. 01 to Dec. 31)	6.0-14.0	365	2013	33.7	-	-	-	-	-
			365	2014	89.6	1.7	13.7	30.0	65.4	0.0
			366	2016	9.8	-	-	-	-	-
			365	2017	99.7	1.6	13.1	42.3	53.6	0.0
			365	2018	100.0	1.8	13.4	30.7	60.0	0.0
			365	2019	100.0	0.6	14.0	34.2	57.5	0.0
			366	2020	71.3	0.6	13.0	31.0	64.4	0.0

Blue shading indicates provincial guideline exceedance of the lower bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

Red shading indicates provincial guideline exceedance of the upper bound of the optimum temperature range by more than 1°C (Oliver and Fidler 2001).

[1] If less than 50 % of the data are available for the life stage period, the statistics are not calculated and data are not included in the summary table.

4.4.7. Bull Trout Temperature Guidelines

Bull Trout specific water temperate guidelines (see Section 3.4.1.1) were applied to the pre- and post-construction water temperature records by calculating the number of days of exceedance of the minimum and maximum temperature thresholds (Table 27). In BC, Bull Trout are considered to have the highest thermal sensitivity of the native salmonids evaluated in Oliver and Fiddler (2001); therefore, more restrictive guidelines are applied to streams with this species. In 2020, the number of days of exceedance of the minimum and maximum temperature thresholds were within the range observed in previous post-construction years.

During both pre- and post-construction monitoring periods, the highest maximum daily temperatures did not exceed the prescribed threshold for rearing (15°C) at either site (Table 27).

The number of days where daily maximum water temperatures were outside the Bull Trout thresholds for spawning and incubation (i.e., >10°C) were higher at the downstream site (ALE-BDGWQ) than at the upstream site (ALE-USWQ1) during both pre- and post-construction monitoring periods. This is due to warmer temperatures in August and September at the downstream site (Table 27, Figure 29), which is likely before the spawning period for Bull Trout on Alena Creek based on data collected to date (Faulkner *et. al* 2021).

The number of days where the minimum temperature was less than the incubation threshold (i.e., <2°C) was also higher at the downstream site due to cooler temperatures at this site during the winter months in comparison to the upstream site which exhibits a warmer temperature regime in the winter likely due to the groundwater input (Figure 29). These results suggest that the temperature regime may be more suitable for Bull Trout at the upper end of the FHEP during spawning and incubation where there are fewer days with temperatures >10°C and <2°C. (Table 27).

Table 27. Summary of the number of days where the daily minimum or maximum water temperature (°C) exceeds the Bull Trout thresholds BC WQG (MOE 2019) in Alena Creek at the upstream site (ALE USWQ1) and downstream site (ALE-BDGWQ).

Site	Project Phase	Year	n (days)[1]	Temperature Thresholds			
				Rearing (Year Round)	Spawning (Aug.1 - Dec. 8)	Incubation (Aug. 1 - Mar. 1)	
				T_{water} > 15°C	T_{water} > 10°C	T_{water} < 2°C	T_{water} > 10°C
ALE-USWQ1[2]	Pre-construction	2013	256	0	0	0	0
		2014	305	0	0	0	0
	Post-construction	2016	38	-	-	-	-
		2017	364	0	14	0	14
		2018	365	0	9	0	9
		2019	364	0	28	1	28
		2020	264	0	20	0	20
ALE-BDGWQ	Pre-construction	2013	125	0	28	44	28
		2014	328	0	57	0	57
	Post-construction	2016	38	-	-	-	-
		2017	364	0	52	48	52
		2018	365	0	46	76	46
		2019	365	0	54	46	54
		2020	264	0	51	0	51

[1] n is the number of days that have observations for at least 23 hours.

T_{water} is the total number of days where the minimum or maximum water temperature is outside the BC WQG (MOE 2019) for the Bull Trout incubation period: August 1 - March 1, spawning period: August 1 to December 8, and rearing period: January 1 to December 31.

[2] Pre-construction data collected at the upstream site excludes February 2014 data based on suspected ice/frozen temperature loggers.

A dash "-" indicates that there were not enough data to calculate the metric.

5. SUMMARY AND RECOMMENDATIONS

The success of the FHEP will be evaluated according to the criteria in the *Fisheries Act* Authorization, namely that the habitat enhancement is physically stable, maintains suitable flows, has been demonstrated to provide spawning and rearing habitat for Coho Salmon and Cutthroat Trout of not less than 2,310 m^2, and supports equivalent or greater fish usage relative to pre-project densities in Alena Creek. Year 4 monitoring results suggest the FHEP is meeting criteria outlined in the *Fisheries Act* Authorization, however this will be further evaluated following Year 5 monitoring. Details of the monitoring to be conducted to evaluate the effectiveness of the FHEP are described in the Project's OEMP (Harwood *et al.* 2017); however, based on the results of Year 4 monitoring, we recommend that the adjustments outlined below are made.

5.1. Fish Habitat

The overall function and quality of the FHEP remains high, despite the flood event that occurred a few months after construction. In both Reach 1 and Reach 3, we recommend continued monitoring of the channel in through an annual walk of the full channel length to examine any locations that pose risk of avulsion or excessive erosion. Recording visual documentation through repeated photos of the surveyed transects should also be continued each year. Specific areas to focus on are described below.

In Reach 1 (downstream), the log jam and associated bank erosion at 0+185 m just upstream of ALE-XS1 should be examined to ensure it does not grow. If it begins to cause backwatering of upstream riffles and associated fine sediment deposition, then it should be removed.

In Reach 3 (upstream), the reconstructed weir at the downstream extent of the reach should be monitored to ensure that it successfully prevents further erosion and associated incision upstream. New beaver activity was observed in the lower end of Reach 3 near ALE-XS5 and upstream of ALE-XS6 and ALE-XS7. The newly formed dams created moderate backwatering in the lower portion of Reach 3 which has been managed in accordance with best management practices for dam removal provided by a licensed trapper from EBB Environmental Consulting Inc. Although the beaver complex upstream of Reach 3 was considered to be inactive in 2020, we recommend ongoing management of beaver dams; in particular, we recommend ensuring that the beaver dam complex above Reach 3 does not grow or further redirect flows around the constructed channel, and removal of the dams in the lower section of Reach 3.

Establishment of herbaceous plants along the constructed channel banks has been successful in protecting the channel banks. Installing additional live stakes was considered but is not recommended at this time since it could increase local beaver activity.

5.2. Fish Community

The fish community component of the Alena Creek FHEP monitoring was successfully implemented in 2020. The 2020 monitoring documented the highest abundance of adult Coho Salmon to date and high minnow trapping CPUE of juvenile Coho Salmon and Cutthroat Trout. The capture of fish in the enhanced sites in 2020 (average CPUE 65.9 Coho/100 trap hours and 3.8 Cutthroat/100 trap hours) provides evidence of use and suggests high quality habitat in the enhanced sites. However, the unenhanced sites had higher CPUE (average CPUE 94.4 Coho/100 trap hours and 4.9 Cutthroat/100 trap hours) indicating that these unenhanced sites also provide high quality habitat. No adult Bull Trout were observed in 2020 and no juveniles were captured during minnow trapping. The limited observations of spawning Bull Trout in 2020 follows a general trend observed in Alena Creek and in nearby 29.2 km reference stream (Faulkner *et. al.* 2021). We recommend that the monitoring program continue in 2021 following the methods used in 2020.

5.3. Hydrology

We recommend that the hydrology monitoring program continue for another year, for a total of five years post-construction as per the OEMP (Harwood *et al.* 2017).

5.4. Water Temperature

The 2020 water temperature regime was within the temperature ranges observed in previous post-construction monitoring (2016 to 2019) and 2019 remains the year with the highest (11.7°C) and lowest (1.2°C) monthly average temperatures on record both occurring at the downstream water temperature monitoring site. To date, no substantial changes in the instantaneous temperature range across the FHEP were observed in the pre- (0.0°C to 14°C) and post-construction (0.0°C to 14.5°C) periods.

Results to date indicate that the FHEP provides water temperatures typical of the area, with beneficial moderating effects due to groundwater inflow upstream of the habitat. Overall temperatures are more suitable for Bull Trout than Coho Salmon and Cutthroat Trout due to the generally cooler optimum temperature ranges for Bull Trout.

Considering inter-annual variability, no substantial differences were observed in the pre- and post-construction temperature regimes. We recommend that the monitoring program continue for another year for a total of five years post-construction based on the methodologies and schedule prescribed in the Project OEMP (Harwood *et al.* 2017).

6. CLOSURE

The monitoring objectives for Year 4 monitoring of the Alena Creek FHEP were achieved, as described in the OEMP (Harwood *et al.* 2017).

REFERENCES

Blackwell, B.G, Brown, M.L., and D.W. Willis. 2000. Relative Weight (Wr) Status and Current Use in Fisheries Assessment and Management. Rev. Fish. Sci., 8: 1-44.

Buchanan, S., A. Newbury, S. Faulkner, A. Harwood, and D. Lacroix. 2013a. Upper Lillooet Hydro Project: Upper Lillooet River Hydroelectric Facility Summary of Aquatic and Riparian Footprint Impacts. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., May 2, 2013.

Buchanan, S., A. Harwood, A. Newbury, and D. Lacroix. 2013b. Upper Lillooet Hydro Project: Boulder Creek Hydroelectric Facility Summary of Aquatic and Riparian Footprint Impacts. Consultant's report prepared for Boulder Creek Power Limited Partnership by Ecofish Research Ltd., May 2, 2013.

Coleman, M.A. and K.D. Fausch. 2007. Cold summer temperature limits recruitment of age-0 cutthroat trout in high-elevation Colorado streams. Transactions of the American Fisheries Society 136(5):1231-1244.

DFO and MELP (Fisheries and Oceans Canada and Ministry of Environment, Land and Parks). 1998. Riparian Revegetation. Available online at: http://www.dfo-mpo.gc.ca/Library/315523.pdf. Accessed on November 24, 2014.

Faulkner, F., M. Thornton, O. Fitzpatrick, S. Braig, T. Jensma, K. Ganshorn, V. Dimma, A. Newbury, and H. Regehr. Upper Lillooet Hydro Project Operational Environmental Monitoring: Year 3. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership by Ecofish Research Ltd., April 29, 2021.

Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41: 540–51

Green, R.N. and Klinka, K. 1994. A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region, Land Management Handbook Number 28. Province of British Columbia. Available online at: https://www.for.gov.bc.ca/hfd/pubs/docs/Lmh/Lmh28.pdf. Last accessed: April 13, 2020.

Harwood, A., A. Yeomans-Routledge, S. Faulkner, and A. Lewis. 2013. Upper Lillooet Hydro Project: Pre-construction and LTMP Report for Alena Creek Compensation Habitat. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd. August 15, 2013.

Harwood, A. E. Smyth, D. McDonnell, A. Newbury, P. Dinn, A. Baki, T. Jensma, and D. Lacroix. 2016. Alena Creek Fish Habitat Enhancement Project: Pre-construction Aquatic Report Years 1 & 2. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., July 14, 2016.

Harwood, A. E. Smyth, D. McDonnell, A. Newbury, P. Dinn, A. Baki, T. Jensma, and D. Lacroix. 2016. Alena Creek Fish Habitat Enhancement Project: Baseline Aquatic Report Years 1 & 2. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., July 14, 2016.

Harwood, A., S. Faulkner, K. Ganshorn, D. Lacroix, A. Newbury, H. Regehr, X. Yu, D. West, A. Lewis, S. Barker and A. Litz. 2017. Upper Lillooet Hydro Project: Operational Environmental Monitoring Plan. Consultant's report prepared for the Upper Lillooet River Power Limited Partnership and the Boulder Creek Power Limited Partnership. March 17, 2017.

Harwood, A., S. Faulkner, K. Ganshorn, D. Lacroix, A. Newbury, H. Regehr, X. Yu, D. West, A. Lewis, S. Barker and A. Litz. 2018. Upper Lillooet Hydro Project: Operational Environmental Monitoring Plan. Consultant's report prepared for the Upper Lillooet River Power Limited Partnership and the Boulder Creek Power Limited Partnership. February 8, 2018.

Harwood, A., V. Woodruff, A. Parsamanesh, S. Faulkner, A. Baki, S. Buchanan, T. Jensma, K. Ganshorn, A. Newbury, and D. Lacroix. 2019a. Alena Creek Fish Habitat Enhancement Project: Year 1 Monitoring Report. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., March 12, 2019.

Harwood, A., S. Sharron, T. Hicks, S. Faulkner, T. Jensma, K. Ganshorn, A. Newbury, and D. Lacroix. 2019b. Alena Creek Fish Habitat Enhancement Project: Year 2 Monitoring Report. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., April 25, 2019.

Hemmera (Hemmera Envirochem Inc.). 2015. Upper Lillooet Hydro Project Offsetting Plan. Consultant's report prepared for the Upper Lillooet River Power Limited Partnership by Hemmera Envirochem Inc. January 2015.

MOE (B.C. Ministry of Environment). 2019. Summary of Water Quality Guidelines: Aquatic Life, Wildlife and Agriculture. Available online at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/wqgs-wqos/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf. Accessed on April 19, 2019.

MOE (Ministry of Environment). 2009. South Coast Region. Periods of Least Risk for Instream Works by Fish Species. Available online at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/working-around-water/work_windows_low_main.pdf. Accessed on March 9, 2021.

Naiman, R.J. and H. Decamps. 1997. The ecology of interfaces: riparian zones. Annual Review of Ecology and Systematics. 28: 621-658

Naiman, R.J., R.E. Bilby, and P.A. Bisson. 2000. Riparian Ecology and Management in the Pacific Coastal Rainforest. Bioscience. 50: 996-1011.

Oliver, G.G. and L.E. Fidler. 2001. Towards a water quality guideline for temperature in the Province of British Columbia. Prepared for Ministry of Environment, Lands and Parks, Water Management Branch, Water Quality Section, Victoria, B.C. Prepared by Aspen Applied Sciences Ltd., Cranbrook, B.C., 53 pp + appnds. Available online at: http://www.env.gov.bc.ca/wat/wq/BCguidelines/temptech/index.html. Accessed on May 23, 2012.

Richardson, J.S. 2004. Meeting the conflicting objectives of stream conservation and land use through riparian management: another balancing act. Pp. 1 - 6 In: G. J. Scrimgeour, G. Eisler, B. McCulloch, U. Silins and M. Monita (Eds.) Forest-Land-Fish Conference II - Ecosystem Stewardship Through Collaboration. Proc. Forest-Land-Fish Conf. II, April 26-28, 2004, Edmonton, Alberta.

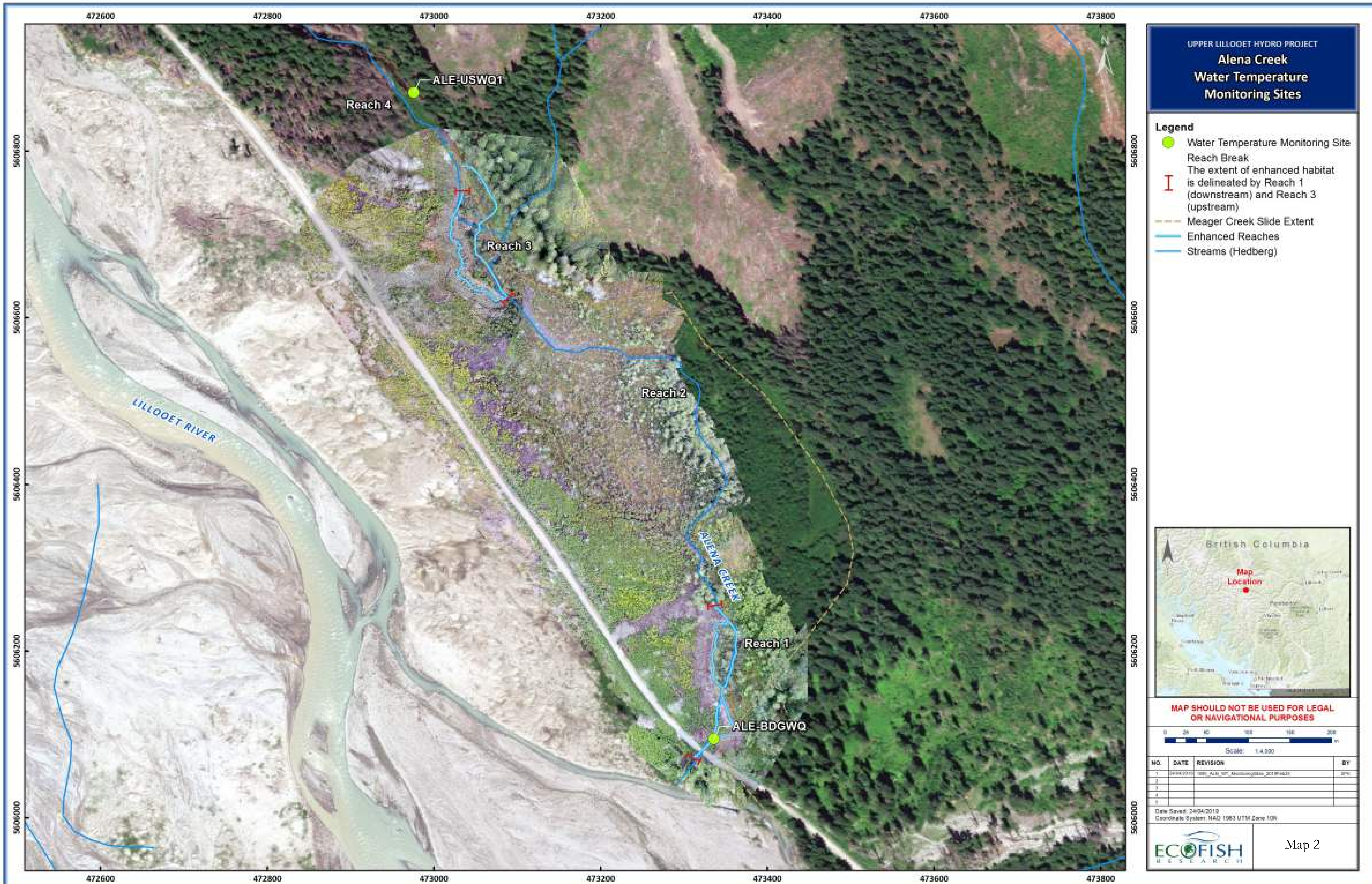
Thornton, M., L. Ballin, T. Jensma, T. Brown, D. West, S. Faulkner, K. Ganshorn, J. Abell 2020. Alena Creek Fish Habitat Enhancement Project: Year 3 Monitoring Report. Draft V1. Consultant's report prepared for Upper Lillooet River Power Limited Partnership by Ecofish Research Ltd., April 28, 2020.

West. D, V. Woodruff and A. Harwood. 2017. Alena Creek Fish Habitat Enhancement Project As-Built Survey. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership by Ecofish Research Ltd. March 7, 2017.

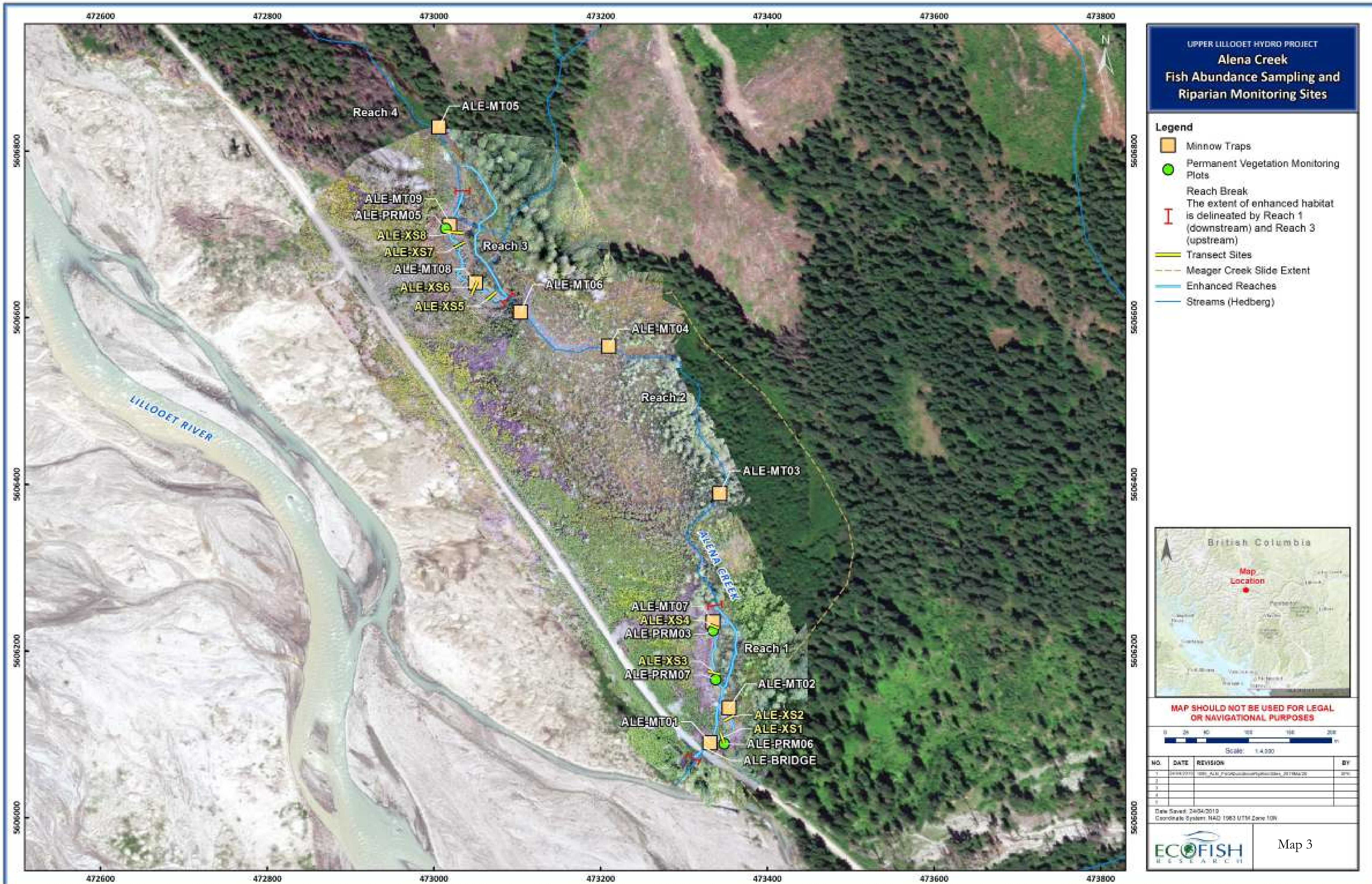
Personal Communications

McCarthy, C. 2014. Senior Engineer, Knight Piésold Ltd., Vancouver, BC. Email communication with J. Mancinelli, Innergex Renewable Energy Inc., March 31, 2014

PROJECT MAPS



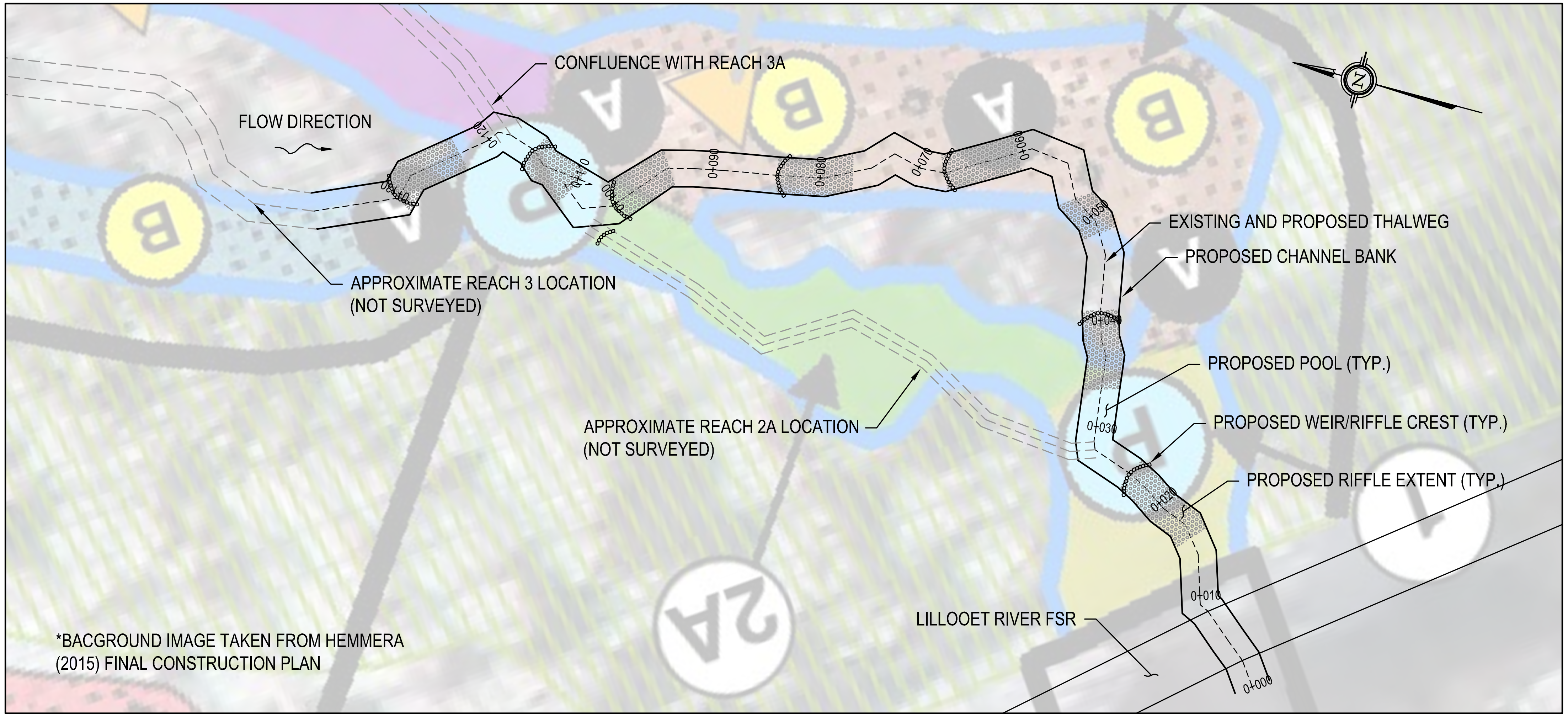
Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\WaterQuality\1095_ALN_WT_MonitoringSites_2019Feb25.mxd



Path: M:\Projects-Active\1095_UPPERLILLOOETPROJECT_NEW\MXD\Fisheries\1095_ALN_FishAbundanceRipMonSites_2019Mar26.mxd

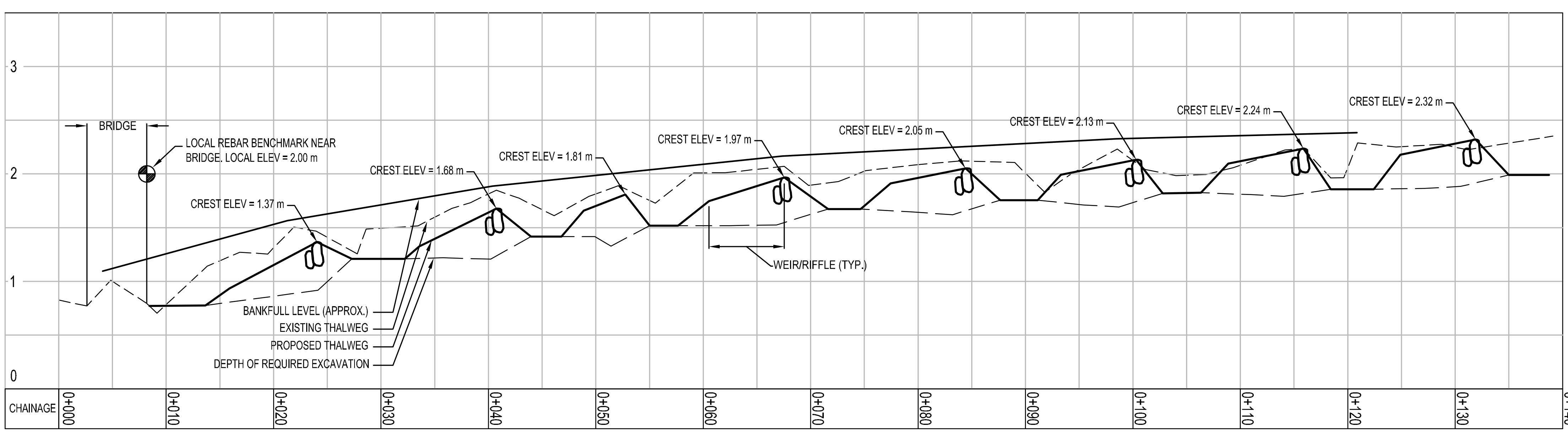
APPENDICES

Appendix A. Final Design Drawings of the Alena Creek Fish Habitat Enhancement Project



REACH 1, 2, & 2A PLANVIEW

1:500



REACH 1, 2, & 2A PROFILE

1:500

GENERAL NOTES

1. THE CONTRACTOR SHALL PROVIDE THE CONSULTING ENGINEER OR GEOMORPHOLOGIST 48 HOURS NOTICE PRIOR TO COMMENCING WORK.
2. THIS SET OF DRAWINGS SHALL BE READ IN CONJUNCTION WITH ACCOMPANYING FINAL CONSTRUCTION PLAN (HEMMERA, 2015).
3. ALL DRAWINGS SHALL BE USED FOR CONSTRUCTION. DO NOT SCALE FROM PLANFORM DRAWING.
4. ALL MEASUREMENTS FOR THIS PROJECT ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE INDICATED.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR LAYOUT, SURVEY AND LOCATION OF ALL UTILITIES.
6. LOCATION OF FEATURES AND EXTENT OF WORKS SHALL BE REVIEWED AND APPROVED BY ENVIRONMENTAL MONITOR.
7. ALL WORKS SHALL BE SUPERVISED, INSPECTED AND APPROVED BY A ENVIRONMENTAL MONITOR.
8. ALL WORKS AND MATERIALS SHALL BE IN ACCORDANCE WITH APPLICABLE MUNICIPAL AND/OR PROVINCIAL STANDARD SPECIFICATIONS AND DRAWINGS.
9. ALL GENERAL BACKFILL SHALL BE APPROVED MATERIAL COMPACTED TO 85% STANDARD PROCTOR DENSITY.
10. ALL UNSUITABLE AND/OR EXCESS MATERIALS SHALL BE DEPOSITED IN A SPOIL AREA DETERMINED BYENVIRONMENTAL MONITOR.
11. IMMEDIATELY AFTER CONSTRUCTION, ALL DISTURBED AREAS SHALL BE STABILIZED AND/OR RESTORED TO ORIGINAL CONDITION.
12. THE CONTRACTOR SHALL REMOVE ALL SEDIMENT CONTROLS AFTER VEGETATION HAS ESTABLISHED. WORKS WILL NOT BE CONSIDERED COMPLETE UNTIL ALL TEMPORARY SEDIMENT CONTROLS ARE REMOVED.

WATERCOURSE PROTECTION

1. MITIGATION MEASURES SECTION OF HEMMERA (2015) FINAL CONSTRUCTION PLAN TO BE REVIEWED AND ADHERED TO.
2. ALL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED AS PER APPLICABLE PLANS.
3. ADDITIONAL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED IF IT IS DETERMINED THAT APPROVED CONTROLS DO NOT ADEQUATELY PREVENT EROSION AND RELEASE OF SEDIMENT.
4. WHERE WORK IN A WATERCOURSE OR ON WATERCOURSE BANKS IS NOT REQUIRED, EQUIPMENT SHALL NOT BE OPERATED IN SUCH AREAS.
5. WHERE WORK IN A WATERCOURSE OR ON WATERCOURSE BANKS IS REQUIRED, THE USE OF EQUIPMENT WITHIN THE WATERCOURSE SHALL BE MINIMIZED.
6. WORK IN A WATERCOURSE AND ON WATERCOURSE BANKS SHALL BE COMPLETED IN THE DRY IN AN ISOLATED WORK AREA DURING LOW-FLOW CONDITIONS.
7. THE WEATHER FORECAST SHALL BE CONTINUALLY MONITORED TO ENSURE THAT CONSTRUCTION ACTIVITIES MAY PROCEED UNDER FAVOURABLE CONDITIONS.
8. EXCAVATION OF THE WATERCOURSE BED AND PLACEMENT OF MATERIALS SHALL BE STAGED SO THAT NO EXCAVATED AREAS REMAIN EXPOSED AT THE END OF EACH WORKING DAY.
9. IF FLOWS WITHIN A WATERCOURSE ARE OBSERVED TO RISE TO A LEVEL APPROACHING THE PUMPING CAPACITY, PLACEMENT OF MATERIALS IN EXCAVATED AREAS MUST BE COMPLETED AS SOON AS POSSIBLE, AFTER WHICH WORK MUST BE SHUT DOWN UNTIL THE FLOW RETURNS TO A LEVEL WITHIN THE PROVIDED PUMPING CAPACITY.
10. ALL EQUIPMENT SHALL BE CLEAN AND FREE OF PETROLEUM PRODUCTS.
11. ALL MAINTENANCE, REFUELING AND STORAGE OF EQUIPMENT SHALL BE CONTROLLED SO AS TO PREVENT ANY DISCHARGE OF PETROLEUM PRODUCTS. VEHICULAR MAINTENANCE AND REFUELING SHALL BE CONDUCTED AWAY FROM WATERCOURSES AND WATERCOURSE BANKS.
12. CONSTRUCTION MATERIAL, EXCESS MATERIAL, CONSTRUCTION DEBRIS AND EMPTY CONTAINERS SHALL BE STORED AWAY FROM WATERCOURSES AND WATERCOURSE BANKS.

	07-10-16	D.W.	ISSUED FOR CONSTRUCTION
	DATE	BY	REVISIONS

DESIGNED BY:	D.W.	CHECKED BY:	D.W.
DRAWN BY:	D.W.	DATE:	AUGUST 10, 2015

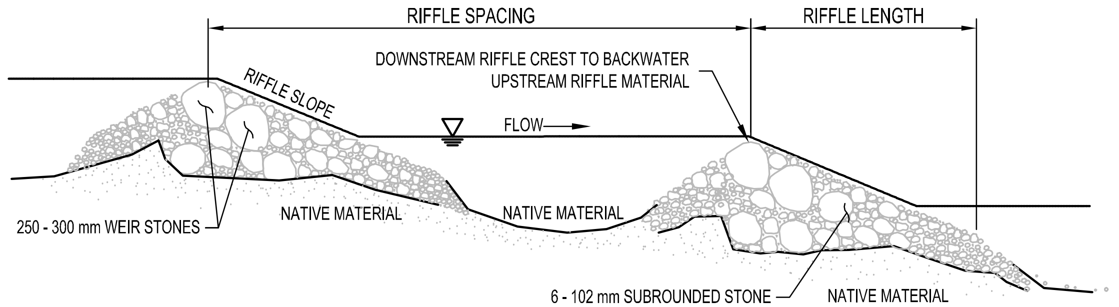
PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — D. I. WEST # 41342

ECOFISH RESEARCH

ALENA CREEK FHEP DETAILED CONSTRUCTION PLAN

REACH 1 AND 2
PLANFORM AND PROFILE

PROJECT No.:	1095.16	DRAWING No.:	GEO-1
SCALE:	AS SHOWN	SHEET 1 OF 3	

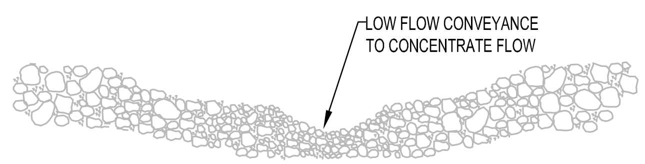


TYPICAL RIFFLE SEQUENCE PROFILE

N.T.S.

CONSTRUCTION NOTES

1. CREST TO CREST CHANNEL GRADIENT IN REACHES 3 TO 6 TO MATCH EXISTING UNLESS OTHERWISE INSTRUCTED BY ENVIRONMENTAL MONITOR.
2. DIG DEPRESSIONS INTO THE BED TO STABILIZE RIFFLE MATERIALS.
3. PLACE LARGEST MATERIAL (KEY STONE) AT RIFFLE CREST (HIGHEST POINT).
4. ENSURE THAT LARGEST ROCKS PROTRUDE INTO FLOW.
5. THICKNESS OF RIFFLE SUBSTRATE AT CREST IS APPROXIMATELY 400 mm.
6. FILL VOIDS IN RIFFLE WITH NATIVE MATERIALS.
7. TAPER GRAIN SIZE AND BED THICKNESS DOWNSTREAM AND UPSTREAM OF CREST.
8. RIFFLE MATERIALS SHOULD EXTEND OVER LIP OF THE DEPRESSION.
9. SPREAD REMAINING ROCK ON RIFFLE TO ATTAIN RIFFLE ANGLE.
10. RIFFLE LENGTH IS DETERMINED FROM PROFILE WHERE SHOWN.
11. SUBSTRATE TO BE MECHANICALLY COMPACTED WITH EXCAVATOR BUCKET TO MINIMIZE INTERSTITIAL SPACING.

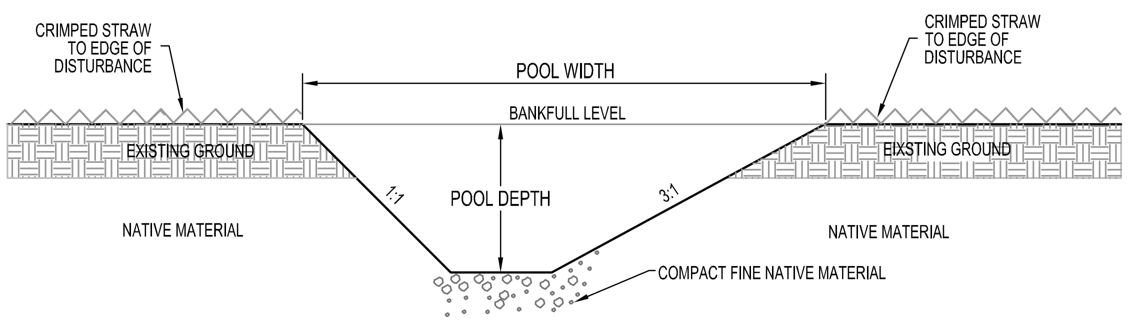


CROSS-SECTION

N.T.S.

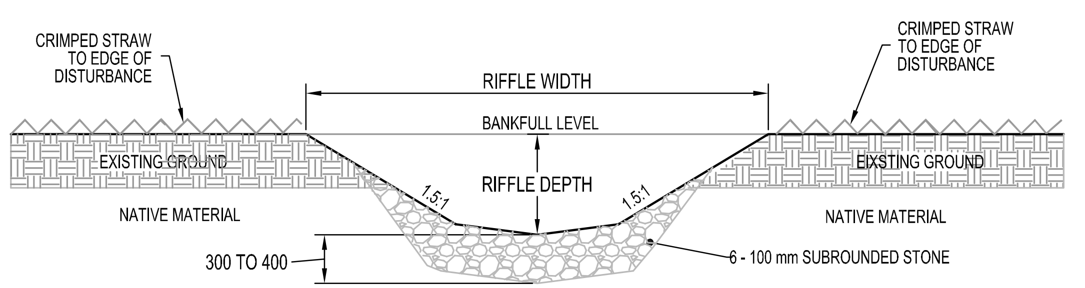
WEIR/RIFFLE CONSTRUCTION DETAILS

N.T.S.



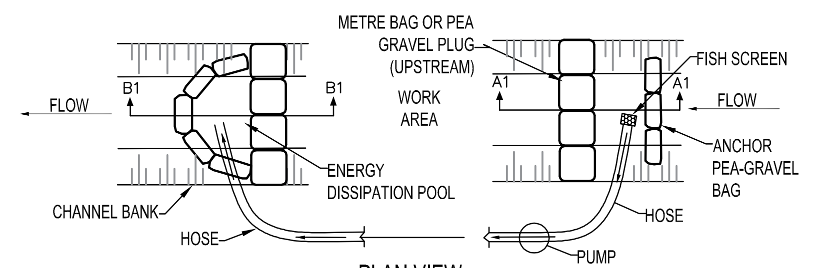
TYPICAL POOL CROSS SECTION

N.T.S.

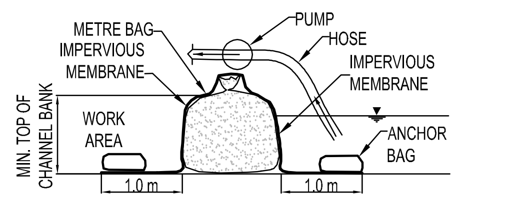


TYPICAL RIFFLE CROSS SECTION

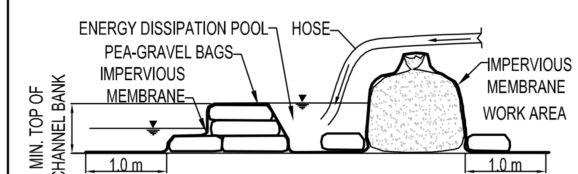
N.T.S.



PLAN VIEW



SECTION A1-A1



SECTION B1-B1

NOTES

1. COFFERDAM BARRIER BAGS TO BE FILLED WITH PEA GRAVEL OR SAND IF PEA GRAVEL IS UNAVAILABLE.
2. IMPERVIOUS MEMBRANE SHALL COVER THE METRE BAGS TO LIMIT WATER ENTRY INTO WORK AREA.
3. PUMPING CAPACITY TO BE A MINIMUM OF 2 - 75 mm (3 in) DIAMETER PUMPS.
4. SCREEN TO BE INSTALLED AT INTAKE END OF HOSE TO LIMIT FISH MORTALITY. FISH SCREEN TO BE 1.25 m^2 WITH A 15 mm MESH SIZE/OPENING.
5. PUMPED WATER SHALL BE DISCHARGED INTO THE ENERGY DISSIPATION POOL.
6. A BACKUP PUMP AND HOSE SHALL BE KEPT ONSITE IN THE EVENT THAT INCREASED FLOWS CANNOT BE PUMPED IN THE PRIMARY SYSTEM.
7. THE CONTRACTOR SHALL MONITOR WEATHER CONDITIONS AND WILL NOT PROCEED WITH WORKS IN THE EVENT OF A STORM EVENT, OR IF IT IS ANTICIPATED THAT FLOWS CANNOT BE PUMPED AROUND AS REQUIRED.

COFFERDAM BARRIER

N.T.S.

CHANNEL GEOMETRY FOR EACH REACH

REACH	RIFFLE SLOPE	RIFFLE LENGTH	RIFFLE SPACING	RIFFLE WIDTH (m)	MAX. RIFFLE DEPTH (m)	POOL WIDTH (m)	MAX. POOL DEPTH (m)
1	SEE GEO-1	SEE GEO-1	SEE GEO-1	2.7	0.35	4.1	0.7
2	SEE GEO-1	SEE GEO-1	SEE GEO-1	2.7	0.35	4.1	0.7
3	2 TO 3 %	5 - 10 m	15 - 18 m	2.7	0.35	4.1	0.7
4	2 TO 3 %	5 - 10 m	15 - 18 m	2.7	0.35	4.1	0.7
5	2 TO 3%	3 - 6 m	10 - 14 m	2.0	0.30	2.9	0.6
6	2 TO 3 %	4 - 8 m	13 - 16 m	2.5	0.35	3.6	0.7

GENERAL NOTES

1. THE CONTRACTOR SHALL PROVIDE THE CONSULTING ENGINEER OR GEOMORPHOLOGIST 48 HOURS NOTICE PRIOR TO COMMENCING WORK.
2. THIS SET OF DRAWINGS SHALL BE READ IN CONJUNCTION WITH ACCOMPANYING FINAL CONSTRUCTION PLAN (HEMMERA, 2015).
3. ALL DRAWINGS SHALL BE USED FOR CONSTRUCTION. DO NOT SCALE FROM PLANFORM DRAWING.
4. ALL MEASUREMENTS FOR THIS PROJECT ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE INDICATED.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR LAYOUT, SURVEY AND LOCATION OF ALL UTILITIES.
6. LOCATION OF FEATURES AND EXTENT OF WORKS SHALL BE REVIEWED AND APPROVED BY ENVIRONMENTAL MONITOR.
7. ALL WORKS SHALL BE SUPERVISED, INSPECTED AND APPROVED BY A ENVIRONMENTAL MONITOR.
8. ALL WORKS AND MATERIALS SHALL BE IN ACCORDANCE WITH APPLICABLE MUNICIPAL AND/OR PROVINCIAL STANDARD SPECIFICATIONS AND DRAWINGS.
9. ALL GENERAL BACKFILL SHALL BE APPROVED MATERIAL COMPACTED TO 85% STANDARD PROCTOR DENSITY.
10. ALL UNSUITABLE AND/OR EXCESS MATERIALS SHALL BE DEPOSITED IN A SPOIL AREA DETERMINED BYENVIRONMENTAL MONITOR.
11. IMMEDIATELY AFTER CONSTRUCTION, ALL DISTURBED AREAS SHALL BE STABILIZED AND/OR RESTORED TO ORIGINAL CONDITION.
12. THE CONTRACTOR SHALL REMOVE ALL SEDIMENT CONTROLS AFTER VEGETATION HAS ESTABLISHED. WORKS WILL NOT BE CONSIDERED COMPLETE UNTIL ALL TEMPORARY SEDIMENT CONTROLS ARE REMOVED.

WATERCOURSE PROTECTION

1. MITIGATION MEASURES SECTION OF HEMMERA (2015) FINAL CONSTRUCTION PLAN TO BE REVIEWED AND ADHERED TO.
2. ALL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED AS PER APPLICABLE PLANS.
3. ADDITIONAL EROSION AND SEDIMENT CONTROLS SHALL BE INSTALLED IF IT IS DETERMINED THAT APPROVED CONTROLS DO NOT ADEQUATELY PREVENT EROSION AND RELEASE OF SEDIMENT.
4. WHERE WORK IN A WATERCOURSE OR ON WATERCOURSE BANKS IS NOT REQUIRED, EQUIPMENT SHALL NOT BE OPERATED IN SUCH AREAS.
5. WHERE WORK IN A WATERCOURSE OR ON WATERCOURSE BANKS IS REQUIRED, THE USE OF EQUIPMENT WITHIN THE WATERCOURSE SHALL BE MINIMIZED.
6. WORK IN A WATERCOURSE AND ON WATERCOURSE BANKS SHALL BE COMPLETED IN THE DRY IN AN ISOLATED WORK AREA DURING LOW-FLOW CONDITIONS.
7. THE WEATHER FORECAST SHALL BE CONTINUALLY MONITORED TO ENSURE THAT CONSTRUCTION ACTIVITIES MAY PROCEED UNDER FAVOURABLE CONDITIONS.
8. EXCAVATION OF THE WATERCOURSE BED AND PLACEMENT OF MATERIALS SHALL BE STAGED SO THAT NO EXCAVATED AREAS REMAIN EXPOSED AT THE END OF EACH WORKING DAY.
9. IF FLOWS WITHIN A WATERCOURSE ARE OBSERVED TO RISE TO A LEVEL APPROACHING THE PUMPING CAPACITY, PLACEMENT OF MATERIALS IN EXCAVATED AREAS MUST BE COMPLETED AS SOON AS POSSIBLE, AFTER WHICH WORK MUST BE SHUT DOWN UNTIL THE FLOW RETURNS TO A LEVEL WITHIN THE PROVIDED PUMPING CAPACITY.
10. ALL EQUIPMENT SHALL BE CLEAN AND FREE OF PETROLEUM PRODUCTS.
11. ALL MAINTENANCE, REFUELING AND STORAGE OF EQUIPMENT SHALL BE CONTROLLED SO AS TO PREVENT ANY DISCHARGE OF PETROLEUM PRODUCTS. VEHICULAR MAINTENANCE AND REFUELING SHALL BE CONDUCTED AWAY FROM WATERCOURSES AND WATERCOURSE BANKS.
12. CONSTRUCTION MATERIAL, EXCESS MATERIAL, CONSTRUCTION DEBRIS AND EMPTY CONTAINERS SHALL BE STORED AWAY FROM WATERCOURSES AND WATERCOURSE BANKS.

	07-10-16	D.W.	ISSUED FOR CONSTRUCTION
	DATE	BY	REVISIONS

DESIGNED BY: D.W. CHECKED BY: D.W.

DRAWN BY: D.W. DATE: AUGUST 10, 2015

D. I. WEST # 41242 ENGINEER

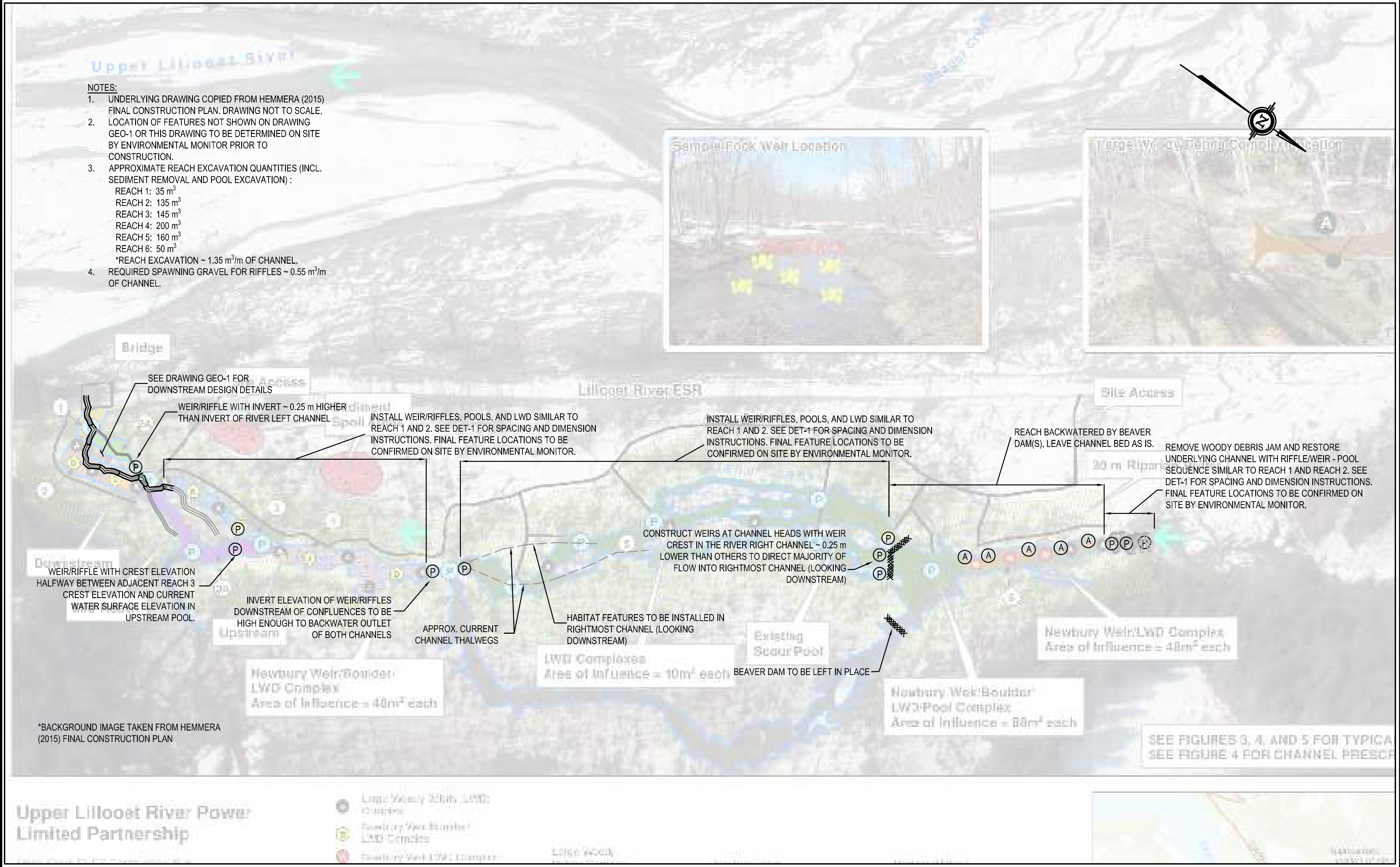
ECOFISH RESEARCH

ALENA CREEK FHEP DETAILED CONSTRUCTION PLAN

CHANNEL GEOMETRY DETAILS

PROJECT No.: 1095.16 DRAWING No.: DET-1

SCALE: AS SHOWN SHEET 2 OF 3



PLANVIEW

N.T.S.

RECOMMENDED CONSTRUCTION SEQUENCE

* MITIGATION MEASURES SECTION OF HEMMERA (2015) FINAL CONSTRUCTION PLAN TO BE ADHERED TO. IF AN APPARENT INCONSISTENCY IS IDENTIFIED, THE ENVIRONMENTAL MONITOR IS TO BE CONSULTED.

PHASE 1 (REACH 1):

1. ISOLATE REACH 1 BY INSTALLING COFFERDAM AND PUMPING OR FLUMING FLOW AROUND SITE.
2. FISH RESCUE OF REACH 1 TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
3. COMPLETE CHANNEL WORKS IN REACH 1 AND REACTIVATE FLOW BY DISMANTLING COFFERDAM.

PHASE 2 (REACH 2 & 2A):

4. ISOLATE REACH 2 BY INSTALLING COFFERDAM AT UPSTREAM EXTENT TO DIVERT FLOW THROUGH REACH 2A.
5. FISH RESCUE OF REACH 1 TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
6. COMPLETE CHANNEL WORKS IN REACH 2 AND REACTIVATE CHANNEL BY SLOWLY DISMANTLING COFFERDAM.
7. ISOLATE REACH 2A BY INSTALLING COFFERDAM AT UPSTREAM EXTENT TO DIVERT FLOW THROUGH REACH 2.
8. CONSTRUCT RIFFLE/WEIR AT HEAD OF REACH 2A WITH CREST ~ 0.25 m HIGHER THAN ADJACENT REACH 2 CREST.

PHASE 3 (REACH 3 & 3A):

9. FEATURE LOCATIONS TO BE ESTABLISHED ON SITE BY ENVIRONMENTAL MONITOR.
10. ISOLATE REACH 3 BY INSTALLING COFFERDAM AT UPSTREAM EXTENT TO DIVERT FLOW THROUGH REACH 3A.
11. FISH RESCUE OF REACH 3 TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
12. COMPLETE CHANNEL WORKS IN REACH 3 BY FOLLOWING INSTALLATION INSTRUCTIONS ON DRAWING DET-1 IN CONSULTATION WITH ECOFISH TECHNICIAN.
13. REACTIVATE REACH 3 BY SLOWLY DISMANTLING COFFERDAM.
14. ISOLATE HEAD OF REACH 3A BY INSTALLING COFFERDAMS ABOVE AND BELOW PROPOSED WEIR LOCATION.
15. FISH RESCUE OF ISOLATED AREA TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
16. PUMP FLOW FROM REACH 4 FORK INTO REACH 3A AT A NATURAL RATE.
17. CONSTRUCT RIFFLE/WEIR AT HEAD OF REACH 3A WITH CREST ELEVATION HALFWAY BETWEEN ADJACENT REACH 3 CREST ELEVATION AND CURRENT WATER SURFACE ELEVATION IN UPSTREAM POOL.
18. REACTIVATE ISOLATED AREA BY DISMANTLING COFFERDAM.

PHASE 4 (REACH 4):

19. FEATURE LOCATIONS TO BE ESTABLISHED ON SITE BY ENVIRONMENTAL MONITOR.
20. ISOLATE FEATURE LOCATIONS ONE AT A TIME BEGINNING AT DOWNSTREAM BY INSTALLING COFFERDAM ABOVE AND BELOW EXTENTS OF FEATURE AND PUMPING OR FLUMING FLOW AROUND ISOLATED AREA.
21. FISH RESCUE OF ISOLATED AREAS TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.

22. PHASE 5 (REACH 5):
23. FEATURE LOCATIONS TO BE ESTABLISHED ON SITE BY ENVIRONMENTAL MONITOR.
24. ISOLATE FEATURE LOCATIONS ONE AT A TIME BEGINNING AT DOWNSTREAM BY INSTALLING COFFERDAM ABOVE AND BELOW EXTENTS AND PUMPING OR FLUMING FLOW AROUND. DIVERSION OF FLOWS INTO ADJACENT CUTOFF CHANNELS MAY ALSO BE FEASIBLE AND WILL BE DISCUSSED WITH ENVIRONMENTAL MONITOR PRIOR TO DIVERSION.
25. FISH RESCUE OF ISOLATED AREAS TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
26. FOR EACH CUTOFF CHANNEL OF REACH 5, COMPLETE STEPS 28 TRHOUGH 32.
27. ISOLATE HEAD OF CUTOFF CHANNEL BY INSTALLING COFFERDAMS ABOVE AND BELOW PROPOSED WEIR LOCATIONS ONE BY ONE.
28. PUMP FLOW AROUND ISOLATED AREA AT A NATURAL RATE.
29. FISH RESCUE OF ISOLATED AREA TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
30. INSTALL RIFFLE/WEIR NEAR HEAD OF CUTOFF CHANNEL DOWNSTREAM OF BEAVERDAM. CREST ELEVATION OF RIGHTMOST CHANNEL TO BE LOWEST. CREST ELEVATIONS TO BE DETERMINED IN FIELD BY ENVIRONMENTAL MONITOR.
31. REACTIVATE ISOLATED AREA BY DISMANTLING COFFERDAM.

PHASE 6 (REACH 6):

32. ISOLATE WOODY DEBRIS JAM BY INSTALLING COFFERDAM ABOVE AND BELOW EXTENTS AND PUMPING OR FLUMIING AROUND.
33. FISH RESCUE OF ISOLATED AREAS TO BE COMPLETED BY A QUALIFIED PROFESSIONAL.
34. REMOVE WOODY DEBRIS PIECES AND DEPOSIT IN SPOIL AREA APPROVED BY ENVIRONMENTAL MONITOR.
35. FEATURES TO BE INSTALLED AT LOCATIONS SPECIFIED BY ENVIRONMENTAL MONITOR ON SITE.
36. REACTIVATE ISOLATED AREA BY DISMANTLING COFFERDAM.

07-10-16	D.W.	ISSUED FOR CONSTRUCTION	
DATE	BY	REVISIONS	

DESIGNED BY:	D.W.	CHECKED BY:	D.W.
DRAWN BY:	D.W.	DATE:	AUGUST 10, 2015

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — D. L. WEST — # 41842

ECOFISH RESEARCH

ALENA CREEK FHEP DETAILED CONSTRUCTION PLAN

FULL SITE PLANFORM AND PHASING

PROJECT No.:	1095.16	DRAWING No.:	PESC-1
SCALE:	AS SHOWN	SHEET 3 OF 3	

Appendix B. Representative Water Temperature Site Photographs

LIST OF FIGURES

Figure 1. Looking downstream at ALE-BDGWQ on September 21, 2020.

Figure 2. Looking upstream at ALE-BDGWQ on September 21, 2020.

Figure 3. Looking RR-RL at ALE-USWQ1 on September 21, 2020.

Figure 4. Looking at ALE-USWQ1 Tidbits on September 21, 2020.

Appendix C. Water Temperature Guidelines and Data Summary.

LIST OF FIGURES

LIST OF TABLES

1. WATER TEMPERATURE GUIDELINES

Table 1. Water temperature guidelines for the protection of freshwater aquatic life (Oliver and Fidler 2001).[1]

Category	Guideline
All Streams	the rate of temperature change in natural water bodies not to exceed 1°C/hr.
	temperature metrics to be described by the mean weekly maximum temperature (MWMxT)
Streams with Known Fish Presence	mean weekly maximum water temperatures should not exceed ±1°C beyond the optimum temperature range for each life history phase of the most sensitive salmonid species present
Streams with Bull Trout or Dolly Varden	maximum daily temperatures should not exceed 15°C
	maximum spawning temperature should not exceed 10°C
	preferred incubation temperatures should range from 2°C to 6°C
	±1°C change from natural condition[1]
Streams with Unknown Fish Presence	salmonid rearing temperatures not to exceed MWMxT of 18°C
	maximum daily temperature not to exceed 19°C
	maximum temperature for salmonid incubation from June until August not to exceed 12°C

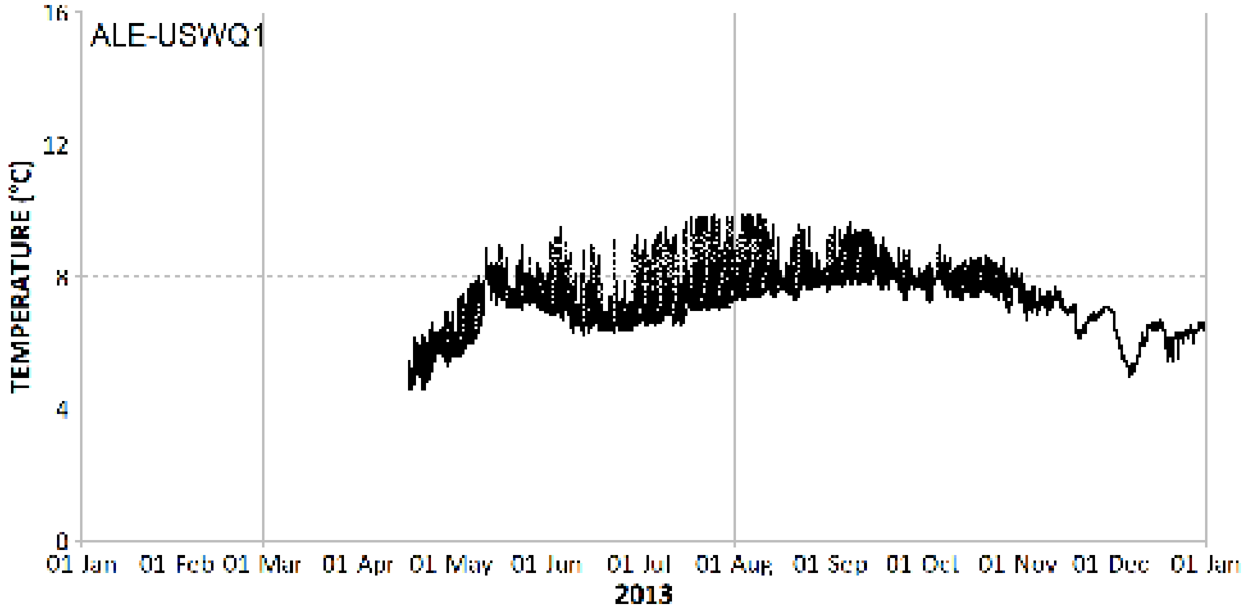
[1] Provided natural conditions are within these guidelines, if they are not, natural conditions should not be altered (Deniseger, pers. comm. 2009).

[1] Deniseger, J. 2009. Section Head, Environmental Quality, Ministry of Environment, Nanaimo, BC. Personal Communication. Telephone conversation with Kevin Ganshorn, June 2009.

2. ANNUAL WATER TEMPERTURE PLOTS

2.1. ALE-USWQ1

Figure 1. ALE-USWQ1 Pre-Construction annual plots (2013 to 2014).



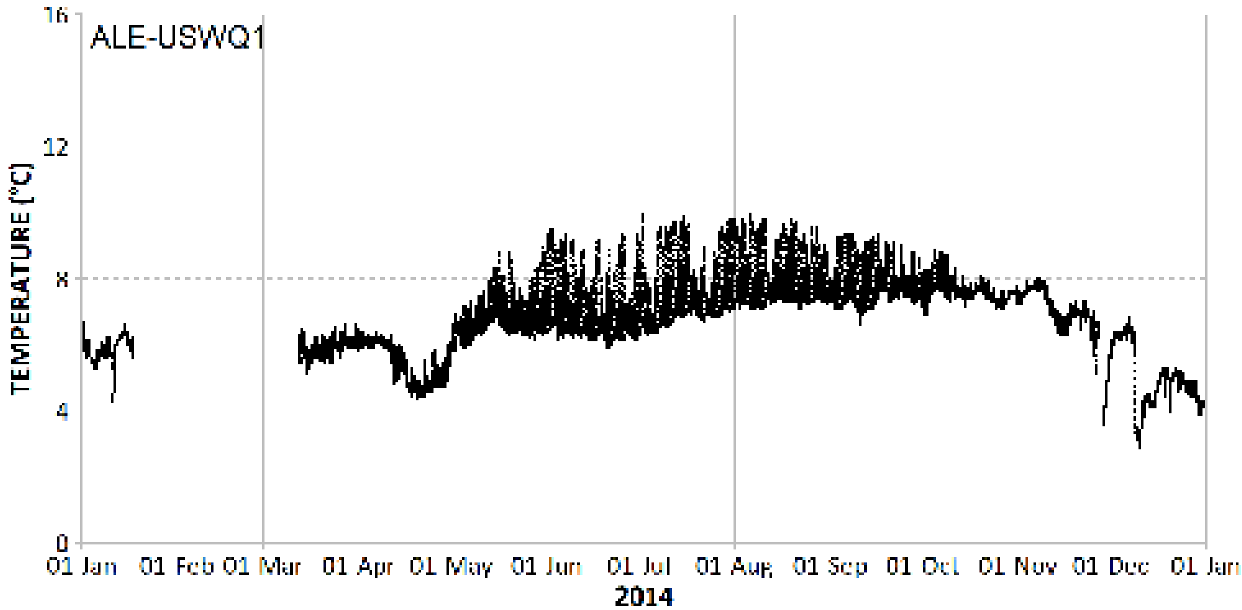
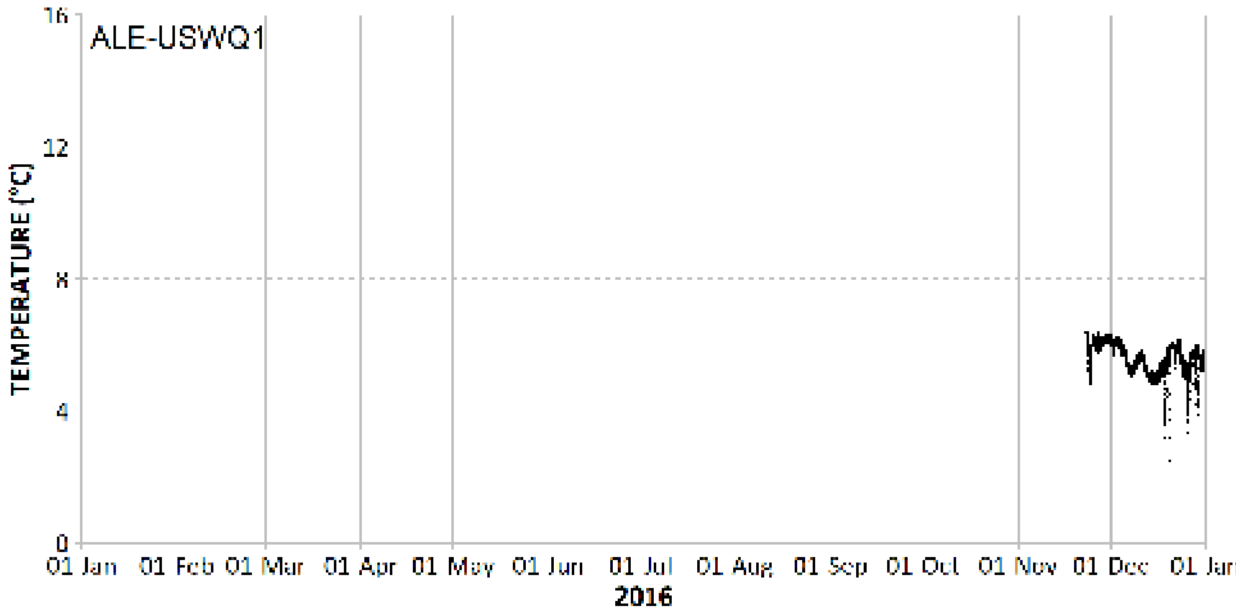


Figure 2. ALE-USWQ1 Post Construction annual plots (2016 to 2020).



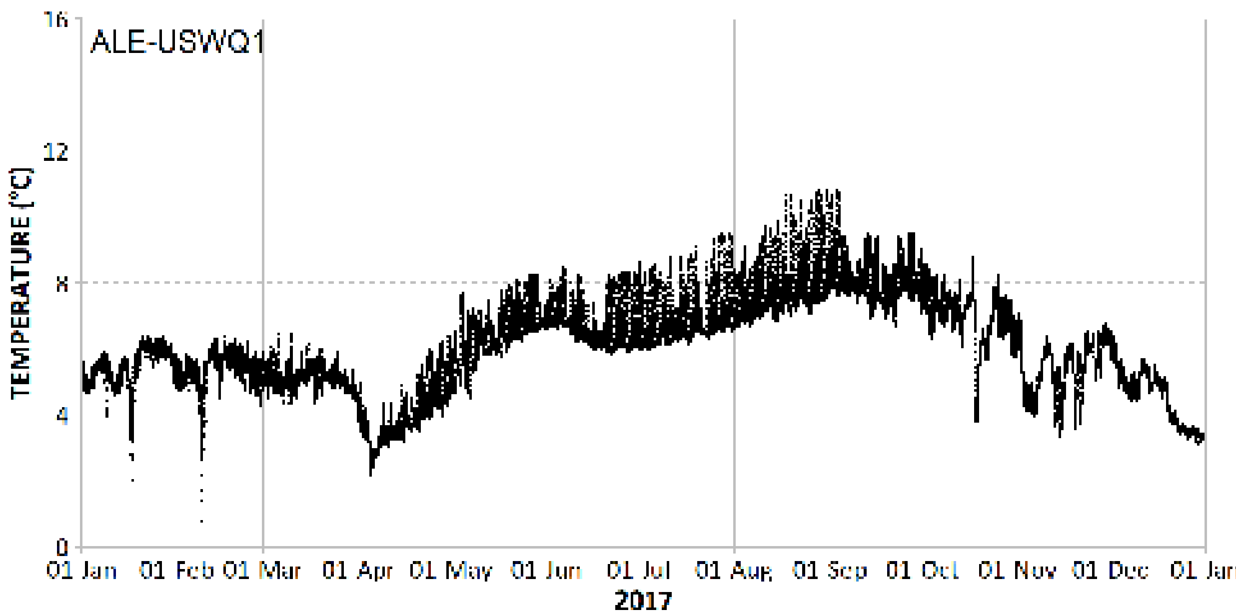
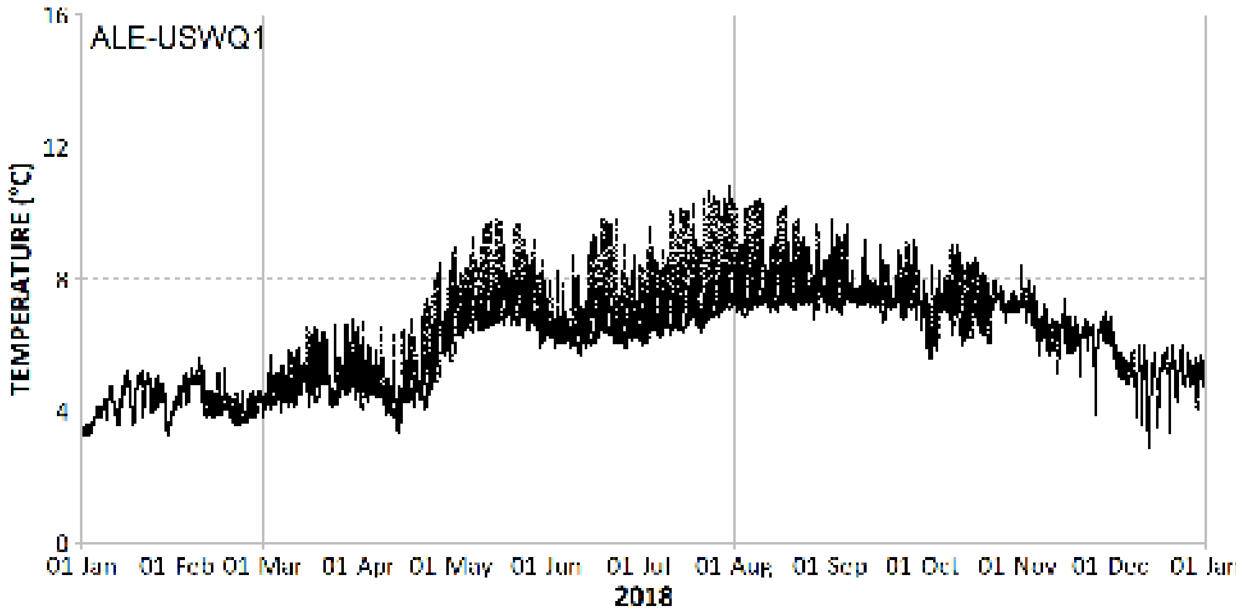


Figure 2. Continued.



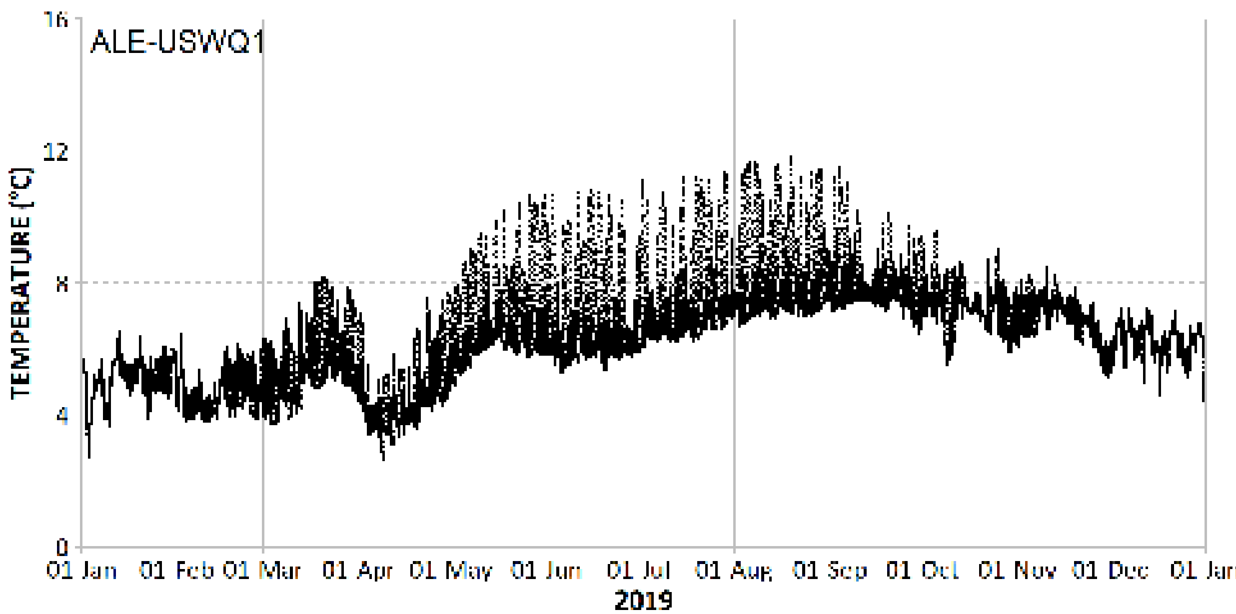
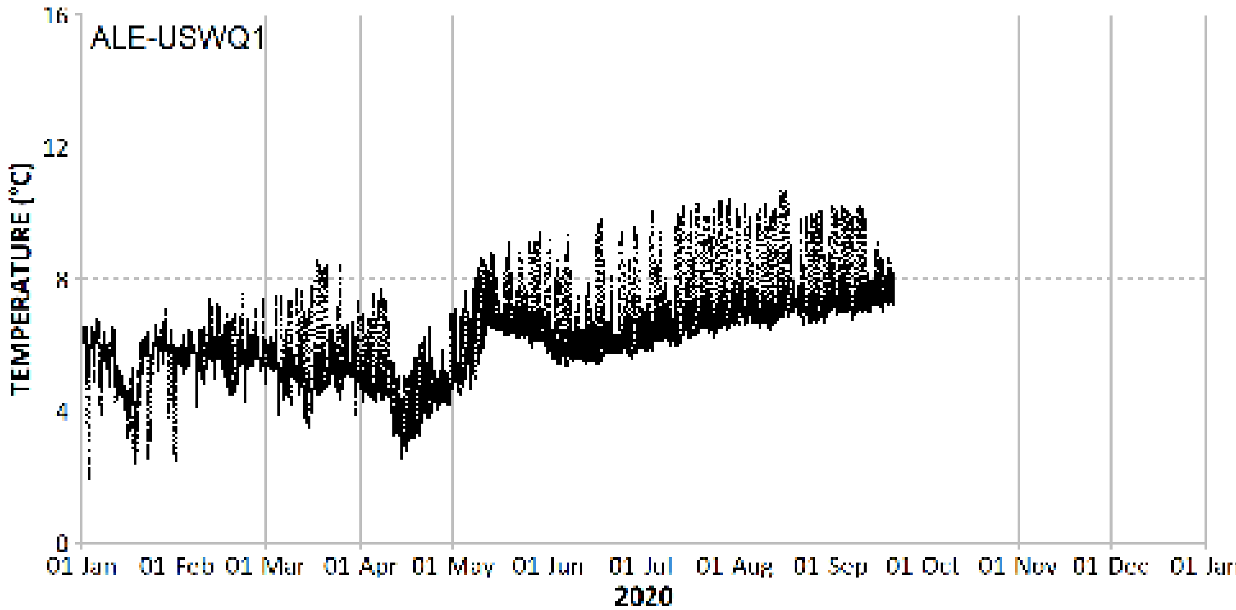


Figure 2. Continued.



2.2. <u>ALE-BDGWQ</u>

Figure 3. ALE-BDGWQ Pre-Construction annual plots (2013 to 2014).

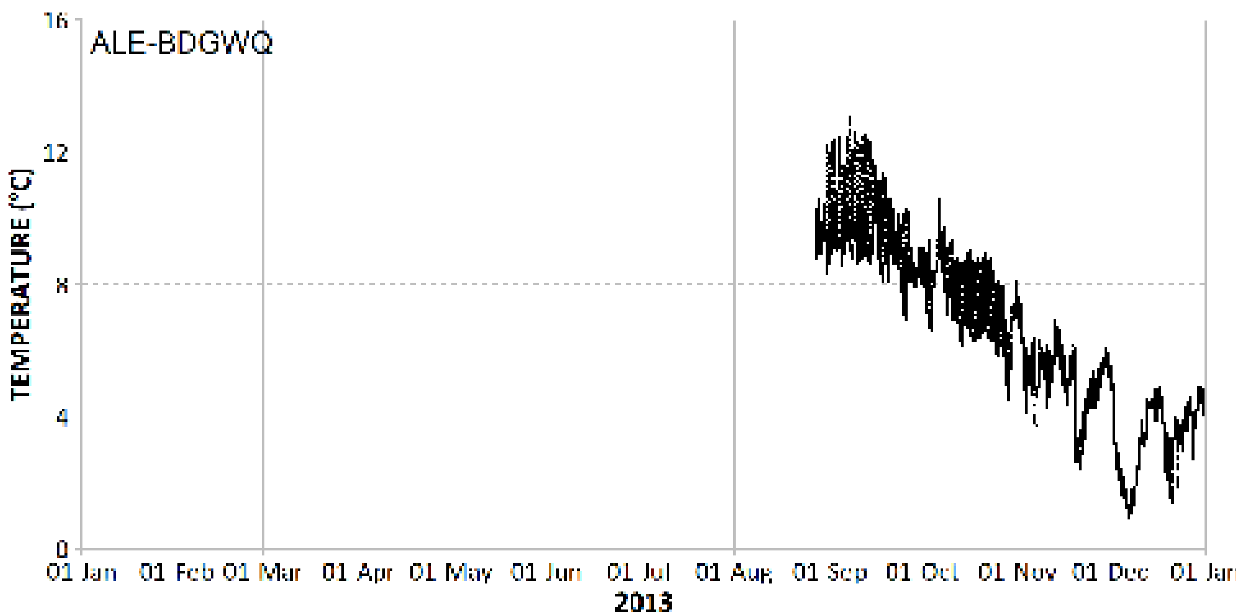


Figure 3. Continued.

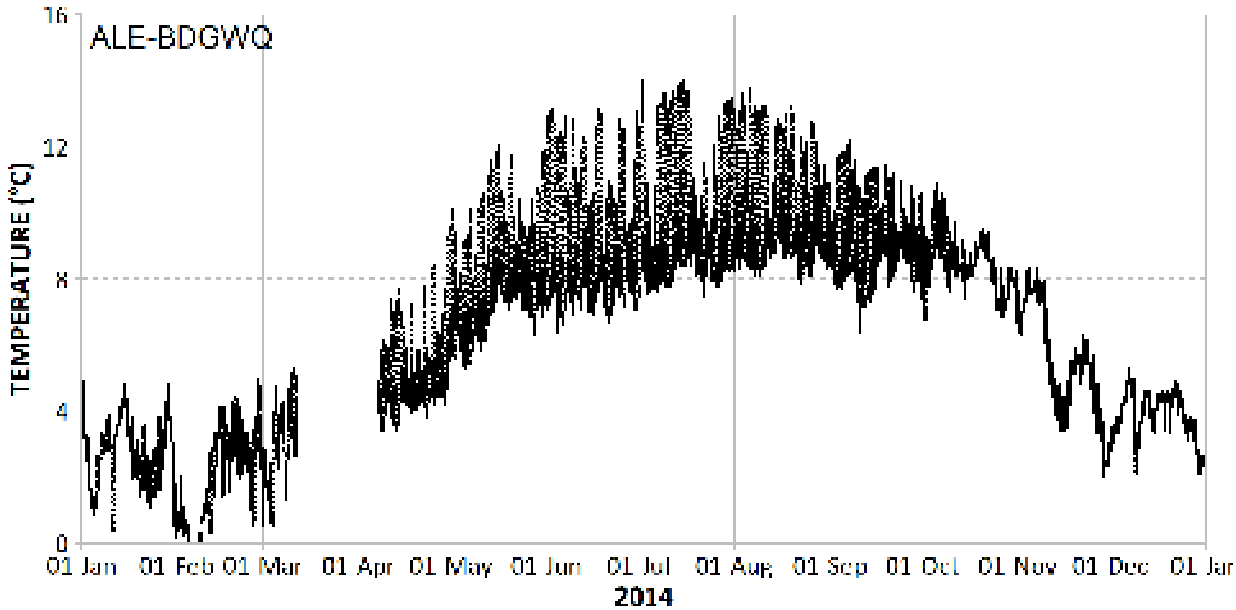


Figure 4. ALE-BDGWQ Post Construction annual plots (2016 to 2020).

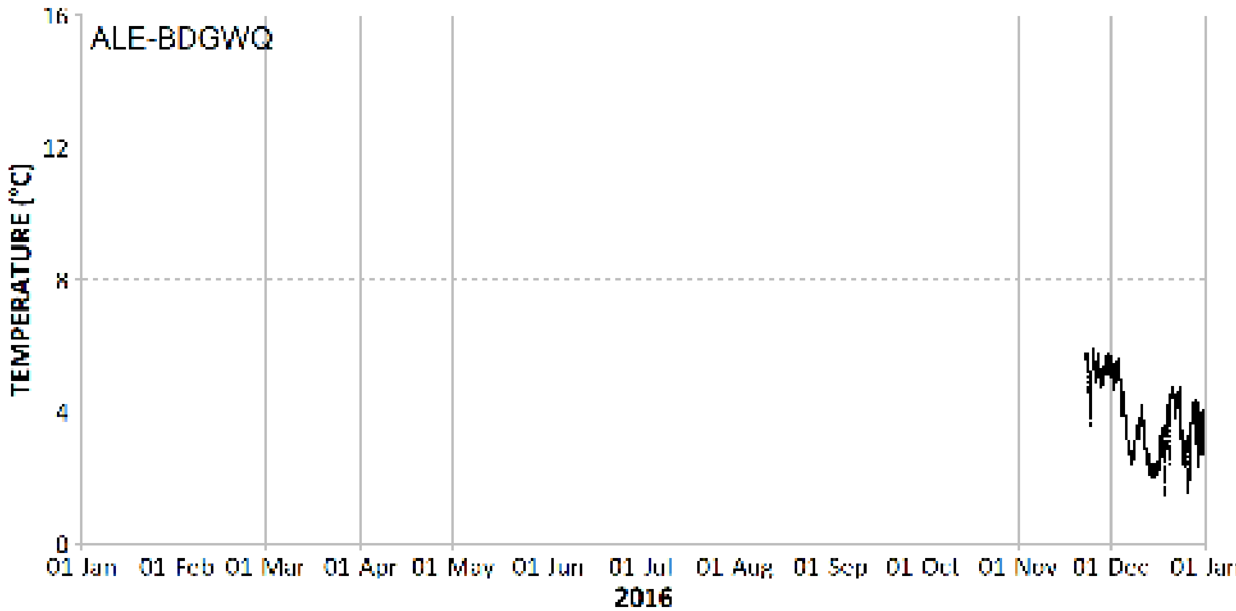
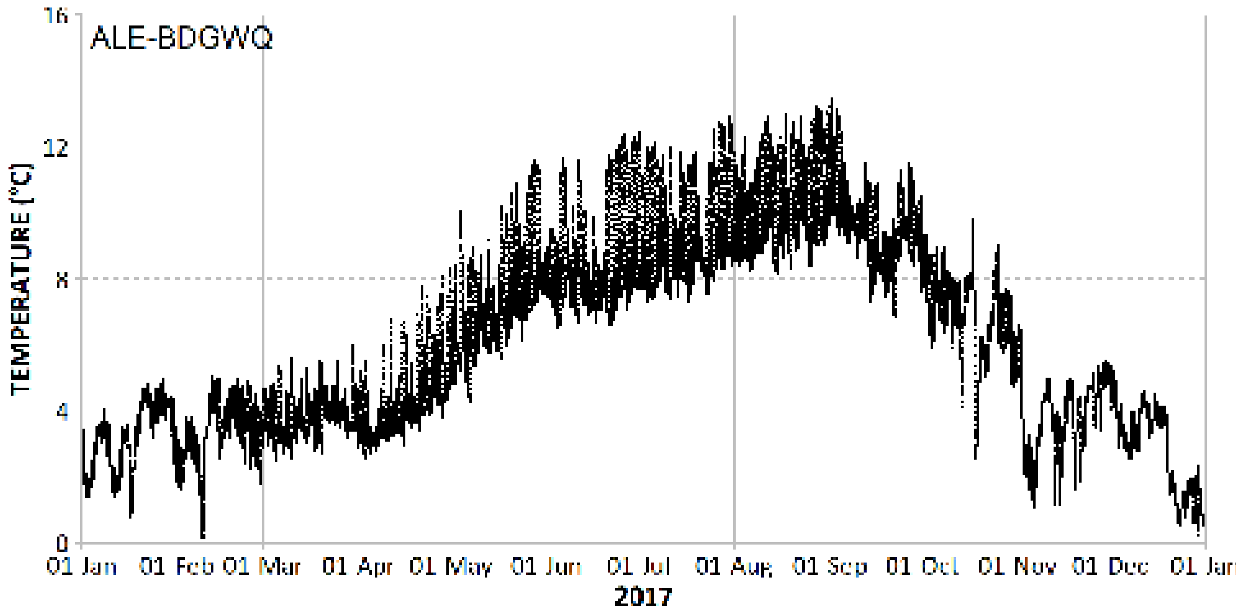


Figure 4. Continued.



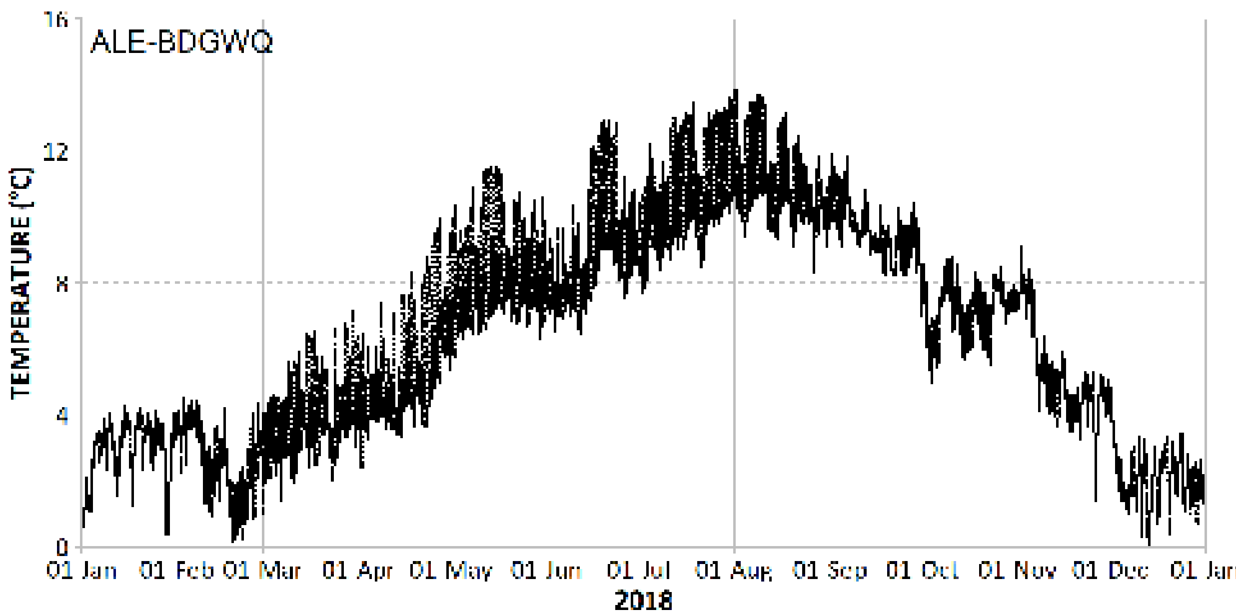
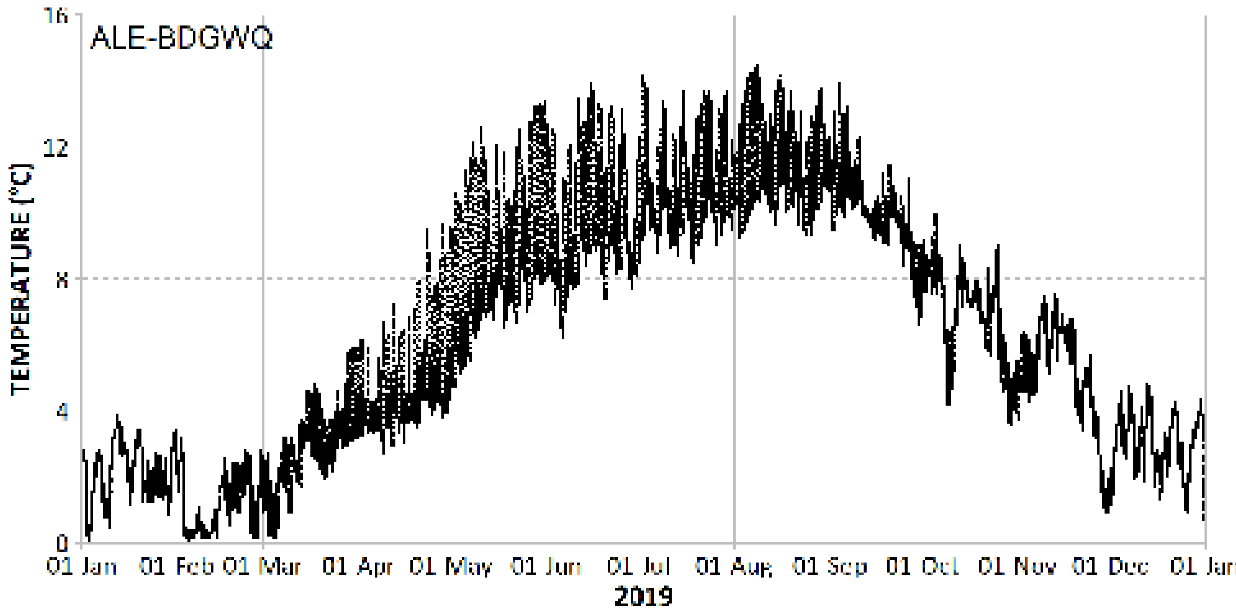
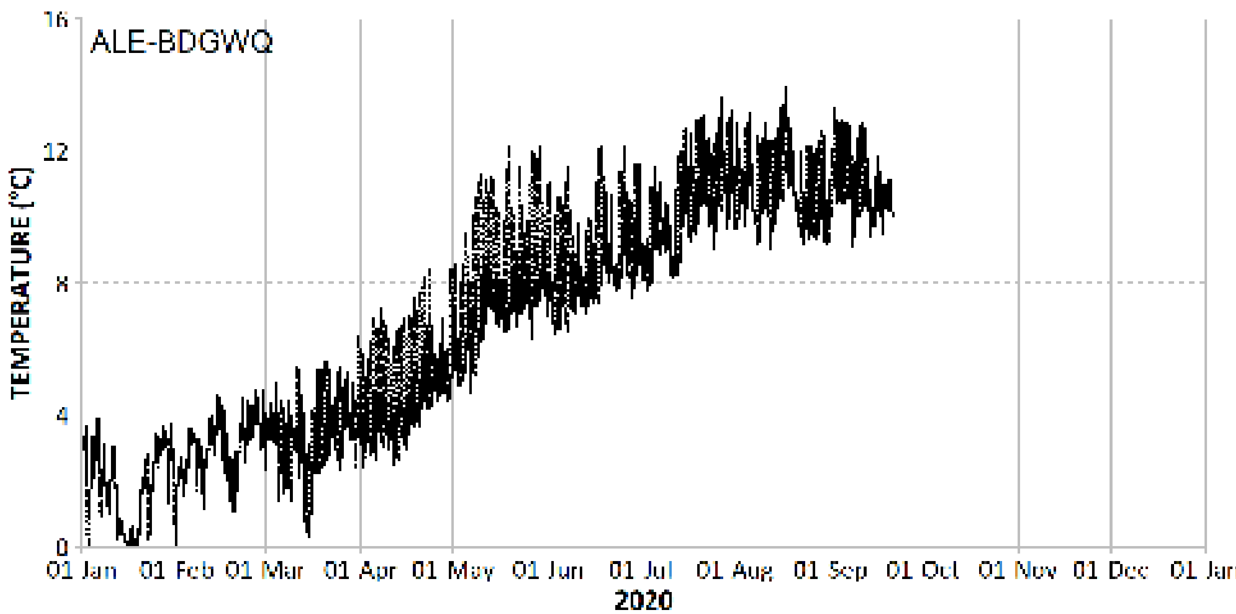


Figure 4. Continued.





Appendix D. Photographs of Alena Creek Fish Habitat Enhancement Project Stability Assessment Year 4 Monitoring

LIST OF FIGURES

Figure 1. ALE-XS1 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 2. ALE-XS1 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 3. ALE-XS1 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 4. ALE-XS1 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 5. ALE-XS1 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 6. ALE-XS2 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 7. ALE-XS2 on November 10, 2017.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 8. ALE-XS2 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 9. ALE-XS2 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 10. ALE-XS2 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 11. ALE-XS3 on September 19, 2016.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 12. ALE-XS3 on November 10, 2017.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 13. ALE-XS3 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 14. ALE-XS3 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 15. ALE-XS3 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 16. ALE-XS4 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 17. ALE-XS4 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 18. ALE-XS4 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 19. ALE-XS4 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 20. ALE-XS4 on November 07, 2020.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 21. ALE-XS5 on September 19, 2016.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 22. ALE-XS5 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 23. ALE-XS5 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 24. ALE-XS5 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 25. ALE-XS5 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 26. ALE-XS6 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 27. ALE-XS6 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 28. ALE-XS6 on November 05, 2018.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 29. ALE-XS6 on November 13, 2019.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 30. ALE-XS6 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 31. ALE-XS7 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 32. ALE-XS7 on November 10, 2017.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 33. ALE-XS7 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 34. ALE-XS7 on November 13, 2019.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 35. ALE-XS7 on November 07, 2020.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 36. ALE-XS8 on September 19, 2016.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 37. ALE-XS8 on November 10, 2017.

a) Looking upstream.

b) Looking downstream.

c) Looking from river right to river left.

d) Looking from river left to river right.

Figure 38. ALE-XS8 on November 05, 2018.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 39. ALE-XS8 on November 13, 2019.

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Figure 40. ALE-XS8 on November 07, 2020

a) Looking upstream.

c) Looking from river right to river left.

b) Looking downstream.

d) Looking from river left to river right.

Appendix E. Raw Data Tables and Representative Photographs from Fish Community Surveys

LIST OF FIGURES

LIST OF TABLES

Figure 1. Minnow trap #3 at sampling site ALE-MT01 on September 20, 2020.

Figure 2. Minnow trap #5 at sampling site ALE-MT02 on September 20, 2020.

Figure 3. Minnow trap #4 at sampling site ALE-MT03 on September 20, 2020.

Figure 4. Minnow trap #2 at sampling site ALE-MT05 on September 20, 2020.

Figure 5. Minnow trap #10 at sampling site ALE-MT06 on September 20, 2020.

Figure 6. Minnow trap #1 at sampling site ALE-MT07 on September 20, 2020.

Figure 7. Minnow trap #2 at sampling site ALE-MT08 on September 20, 2020.

Figure 8. Minnow trap #4 at sampling site ALE-MT09 on September 20, 2020.

Table 1. Summary of minnow traps soak times and capture data at each site.

Site	Trap #	Mesh Size (mm)	Date In	Time In	Date Out	Time Out	Trap Depth (m)	Soak Time (hrs)	Catch[1] CO	CT	BT
ALE-MT01	1	3	20-Sep-20	09:55	21-Sep-20	08:00	0.30	22.08	8	4	0
	2	3	20-Sep-20	09:55	21-Sep-20	08:00	0.35	22.08	1	0	0
	3	3	20-Sep-20	09:55	21-Sep-20	08:00	0.40	22.08	13	1	0
	4	3	20-Sep-20	09:55	21-Sep-20	08:00	0.25	22.08	0	0	0
	5	3	20-Sep-20	09:55	21-Sep-20	08:00	0.30	22.08	8	0	0
ALE-MT02	1	3	20-Sep-20	10:46	21-Sep-20	09:25	0.18	22.65	0	0	0
	2	3	20-Sep-20	10:46	21-Sep-20	09:25	0.45	22.65	20	2	0
	3	3	20-Sep-20	10:46	21-Sep-20	09:25	0.50	22.65	0	0	0
	4	3	20-Sep-20	10:46	21-Sep-20	09:25	0.40	22.65	5	2	0
	5	3	20-Sep-20	10:46	21-Sep-20	09:25	0.20	22.65	0	1	0
ALE-MT07	1	3	20-Sep-20	11:15	21-Sep-20	10:48	0.20	23.55	15	0	0
	2	3	20-Sep-20	11:15	21-Sep-20	10:48	0.30	23.55	1	0	0
	3	3	20-Sep-20	11:15	21-Sep-20	10:48	0.70	23.55	2	2	0
	4	3	20-Sep-20	11:15	21-Sep-20	10:48	0.40	23.55	18	1	0
	5	3	20-Sep-20	11:15	21-Sep-20	10:48	0.35	23.55	18	0	0
ALE-MT03	1	3	20-Sep-20	11:50	21-Sep-20	12:05	0.65	24.25	23	0	0
	2	3	20-Sep-20	11:50	21-Sep-20	12:05	0.45	24.25	16	2	0
	3	3	20-Sep-20	11:50	21-Sep-20	12:05	0.55	24.25	7	2	0
	4	3	20-Sep-20	11:50	21-Sep-20	12:05	0.35	24.25	4	1	0
	5	3	20-Sep-20	11:50	21-Sep-20	12:05	0.20	24.25	7	0	0
ALE-MT06	1	6	20-Sep-20	13:40	21-Sep-20	14:10	0.80	24.50	66	2	0
	2	6	20-Sep-20	13:40	21-Sep-20	14:10	1.00	24.50	51	2	0
	3	6	20-Sep-20	13:40	21-Sep-20	14:10	0.40	24.50	44	0	0
	4	6	20-Sep-20	13:40	21-Sep-20	14:10	0.90	24.50	25	3	0
	5	6	20-Sep-20	13:40	21-Sep-20	14:10	1.40	24.50	27	4	0
	6	6	20-Sep-20	13:40	21-Sep-20	14:10	0.90	24.50	27	2	0
	7	6	20-Sep-20	13:40	21-Sep-20	14:10	0.60	24.50	48	0	0
	8	6	20-Sep-20	13:40	21-Sep-20	14:10	1.10	24.50	16	1	0
	9	6	20-Sep-20	13:40	21-Sep-20	14:10	1.40	24.50	15	3	0
	10	6	20-Sep-20	13:40	21-Sep-20	14:10	0.70	24.50	35	1	0
ALE-MT08	1	3	20-Sep-20	14:10	21-Sep-20	16:10	0.70	26.00	29	0	0
	2	6	20-Sep-20	14:10	21-Sep-20	16:10	0.95	26.00	19	2	0
	3	6	20-Sep-20	14:10	21-Sep-20	16:10	1.10	26.00	24	0	0
	4	3	20-Sep-20	14:10	21-Sep-20	16:10	1.10	26.00	12	0	0
	5	3	20-Sep-20	14:10	21-Sep-20	16:10	0.85	26.00	20	1	0
ALE-MT09	1	6	20-Sep-20	14:42	21-Sep-20	17:00	0.20	26.30	24	2	0
	2	6	20-Sep-20	14:42	21-Sep-20	17:00	0.35	26.30	14	4	0
	3	6	20-Sep-20	14:42	21-Sep-20	17:00	0.32	26.30	14	0	0
	4	6	20-Sep-20	14:42	21-Sep-20	17:00	0.40	26.30	17	2	0
	5	6	20-Sep-20	14:42	21-Sep-20	17:00	0.25	26.30	34	1	0
ALE-MT05	1	6	20-Sep-20	15:10	21-Sep-20	17:25	0.42	26.25	47	0	0
	2	6	20-Sep-20	15:10	21-Sep-20	17:25	0.40	26.25	85	0	0
	3	6	20-Sep-20	15:10	21-Sep-20	17:25	0.35	26.25	5	1	0
	4	6	20-Sep-20	15:10	21-Sep-20	17:25	0.35	26.25	38	0	0
	5	6	20-Sep-20	15:10	21-Sep-20	17:25	0.45	26.25	30	0	0

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout.

Table 2. Detailed fish capture, fork length and aging data.

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT01	20-Sep-20	1	CO	59		2.5	1.22					0
ALE-MT01	20-Sep-20	1	CO	66		2.8	0.97					0
ALE-MT01	20-Sep-20	1	CO	73		4.3	1.11					1
ALE-MT01	20-Sep-20	1	CO	74		4.3	1.06					1
ALE-MT01	20-Sep-20	1	CO	78		5.7	1.20					1
ALE-MT01	20-Sep-20	1	CO	85		7.0	1.14	SC	8			1
ALE-MT01	20-Sep-20	1	CO	88		8.4	1.23					1
ALE-MT01	20-Sep-20	1	CO	89		7.3	1.04					1
ALE-MT01	20-Sep-20	1	CT	86								1
ALE-MT01	20-Sep-20	1	CT	88		6.0	0.88	SC	7			1
ALE-MT01	20-Sep-20	1	CT	119		15.3	0.91	SC	5			2
ALE-MT01	20-Sep-20	1	CT	109		11.9	0.92	SC	6			1
ALE-MT01	20-Sep-20	2	CO	59		3.0	1.46					0
ALE-MT01	20-Sep-20	3	CO	54		2.4	1.52					0
ALE-MT01	20-Sep-20	3	CO	55								0
ALE-MT01	20-Sep-20	3	CO	55		2.4	1.44					0
ALE-MT01	20-Sep-20	3	CO	57		2.5	1.35					0
ALE-MT01	20-Sep-20	3	CO	63		3.0	1.20					0
ALE-MT01	20-Sep-20	3	CO	63		3.4	1.36					0
ALE-MT01	20-Sep-20	3	CO	65		3.2	1.17					0
ALE-MT01	20-Sep-20	3	CO	69		3.9	1.19					0
ALE-MT01	20-Sep-20	3	CO	77		5.8	1.27					1
ALE-MT01	20-Sep-20	3	CO	79		5.8	1.18					1
ALE-MT01	20-Sep-20	3	CO	80		6.2	1.21					1
ALE-MT01	20-Sep-20	3	CO	84		7.0	1.18					1
ALE-MT01	20-Sep-20	3	CO	84		8.7	1.47					1
ALE-MT01	20-Sep-20	3	CT	92		7.7	0.99					1
ALE-MT01	20-Sep-20	4	NFC									
ALE-MT01	20-Sep-20	5	CO	46		1.0	1.03	SC	3			0
ALE-MT01	20-Sep-20	5	CO	50		1.4	1.12					0
ALE-MT01	20-Sep-20	5	CO	52		1.5	1.07					0
ALE-MT01	20-Sep-20	5	CO	56		2.2	1.25					0
ALE-MT01	20-Sep-20	5	CO	60		2.5	1.16	SC	4			0
ALE-MT01	20-Sep-20	5	CO	64		2.8	1.07	SC	1			0
ALE-MT01	20-Sep-20	5	CO	70		4.4	1.28	SC	2			0
ALE-MT01	20-Sep-20	5	CO	70		3.8	1.11					0
ALE-MT02	20-Sep-20	1	NFC									
ALE-MT02	20-Sep-20	2	CO	43		1.1	1.38					0
ALE-MT02	20-Sep-20	2	CO	44		1.6	1.88	SC	3	FC	3	0
ALE-MT02	20-Sep-20	2	CO	45		1.3	1.43					0
ALE-MT02	20-Sep-20	2	CO	49		1.3	1.10					0
ALE-MT02	20-Sep-20	2	CO	50		1.6	1.28					0
ALE-MT02	20-Sep-20	2	CO	51		1.6	1.21					0
ALE-MT02	20-Sep-20	2	CO	51		1.8	1.36					0
ALE-MT02	20-Sep-20	2	CO	54		2.2	1.40					0
ALE-MT02	20-Sep-20	2	CO	54		1.8	1.14					0
ALE-MT02	20-Sep-20	2	CO	55		1.9	1.14	SC	5	FC	5	0
ALE-MT02	20-Sep-20	2	CO	56		2.1	1.20					0
ALE-MT02	20-Sep-20	2	CO	58		1.7	0.87					0
ALE-MT02	20-Sep-20	2	CO	62		3.2	1.34					0
ALE-MT02	20-Sep-20	2	CO	63		3.0	1.20					0
ALE-MT02	20-Sep-20	2	CO	63		3.4	1.36	SC	2	FC	2	0
ALE-MT02	20-Sep-20	2	CO	64		3.4	1.30					0
ALE-MT02	20-Sep-20	2	CO	69		3.4	1.03					0
ALE-MT02	20-Sep-20	2	CO	78		5.6	1.18	SC	4	FC	4	1
ALE-MT02	20-Sep-20	2	CO	80		6.4	1.25	SC	7	FC	7	1
ALE-MT02	20-Sep-20	2	CO	82		8.4	1.52	SC	6	FC	6	1
ALE-MT02	20-Sep-20	2	CT	135		24.6	1.00	SC	1	FC	1	2
ALE-MT02	20-Sep-20	2	CT	99		8.6	0.89					1
ALE-MT02	20-Sep-20	3	NFC									

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (2 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT02	20-Sep-20	4	CO	60		2.3	1.06					0
ALE-MT02	20-Sep-20	4	CO	66		3.1	1.08					0
ALE-MT02	20-Sep-20	4	CO	67		3.5	1.16					0
ALE-MT02	20-Sep-20	4	CO	81		7.5	1.41	SC	10	FC	10	1
ALE-MT02	20-Sep-20	4	CO	83		6.2	1.08					1
ALE-MT02	20-Sep-20	4	CT	74		4.1	1.01	SC	9	FC	9	1
ALE-MT02	20-Sep-20	4	CT	83		6.9	1.21					1
ALE-MT02	20-Sep-20	5	CT	112		14.1	1.00	SC	8	FC	8	1
ALE-MT07	20-Sep-20	1	CO	41		0.9	1.31					0
ALE-MT07	20-Sep-20	1	CO	44		1.2	1.41					0
ALE-MT07	20-Sep-20	1	CO	47		1.2	1.16					0
ALE-MT07	20-Sep-20	1	CO	52		1.7	1.21					0
ALE-MT07	20-Sep-20	1	CO	55		2.0	1.20					0
ALE-MT07	20-Sep-20	1	CO	57		2.1	1.13					0
ALE-MT07	20-Sep-20	1	CO	59		2.4	1.17					0
ALE-MT07	20-Sep-20	1	CO	59		2.3	1.12					0
ALE-MT07	20-Sep-20	1	CO	60		2.1	0.97					0
ALE-MT07	20-Sep-20	1	CO	60		2.6	1.20					0
ALE-MT07	20-Sep-20	1	CO	61		2.6	1.15					0
ALE-MT07	20-Sep-20	1	CO	66		3.5	1.22					0
ALE-MT07	20-Sep-20	1	CO	79		5.4	1.10					1
ALE-MT07	20-Sep-20	1	CO	85		7.1	1.16					1
ALE-MT07	20-Sep-20	1	CO	88		8.3	1.22					1
ALE-MT07	20-Sep-20	2	CO	60								0
ALE-MT07	20-Sep-20	3	CO	55		2.1	1.26					0
ALE-MT07	20-Sep-20	3	CO	91		9.1	1.21					1
ALE-MT07	20-Sep-20	3	CT	82		5.3	0.96					1
ALE-MT07	20-Sep-20	3	CT	83		6.1	1.07	SC	8	FC	8	1
ALE-MT07	20-Sep-20	4	CO	45		1.3	1.43	SC	3	FC	3	0
ALE-MT07	20-Sep-20	4	CO	51		3.0	2.26	SC	5	FC	5	0
ALE-MT07	20-Sep-20	4	CO	52		1.8	1.28					0
ALE-MT07	20-Sep-20	4	CO	55		2.1	1.26					0
ALE-MT07	20-Sep-20	4	CO	60		2.2	1.02					0
ALE-MT07	20-Sep-20	4	CO	64		3.5	1.34					0
ALE-MT07	20-Sep-20	4	CO	64		3.1	1.18					0
ALE-MT07	20-Sep-20	4	CO	65		3.5	1.27					0
ALE-MT07	20-Sep-20	4	CO	70		4.6	1.34					0
ALE-MT07	20-Sep-20	4	CO	73		4.7	1.21					1
ALE-MT07	20-Sep-20	4	CO	79		6.8	1.38					1
ALE-MT07	20-Sep-20	4	CO	79		5.9	1.20					1
ALE-MT07	20-Sep-20	4	CO	84		7.4	1.25					1
ALE-MT07	20-Sep-20	4	CO	85		7.9	1.29	SC	2	FC	2	1
ALE-MT07	20-Sep-20	4	CO	85		6.7	1.09					1
ALE-MT07	20-Sep-20	4	CO	87		7.4	1.12					1
ALE-MT07	20-Sep-20	4	CO	96		10.2	1.15	SC	4	FC	4	1
ALE-MT07	20-Sep-20	4	CO	92		10.0	1.28					1
ALE-MT07	20-Sep-20	4	CT	113		13.8	0.96	SC	1	FC	1	1
ALE-MT07	20-Sep-20	5	CO	41		0.9	1.31					0
ALE-MT07	20-Sep-20	5	CO	42		1.1	1.48					0
ALE-MT07	20-Sep-20	5	CO	44		1.4	1.64					0
ALE-MT07	20-Sep-20	5	CO	44		1.6	1.88					0
ALE-MT07	20-Sep-20	5	CO	45		1.5	1.65					0
ALE-MT07	20-Sep-20	5	CO	49		1.7	1.44					0
ALE-MT07	20-Sep-20	5	CO	49		1.2	1.02					0
ALE-MT07	20-Sep-20	5	CO	50		1.5	1.20					0
ALE-MT07	20-Sep-20	5	CO	50		2.1	1.68					0
ALE-MT07	20-Sep-20	5	CO	52		2.2	1.56					0
ALE-MT07	20-Sep-20	5	CO	54		2.3	1.46					0
ALE-MT07	20-Sep-20	5	CO	55		2.0	1.20					0
ALE-MT07	20-Sep-20	5	CO	55		3.1	1.86	SC	6	FC	6	0

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (3 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT07	20-Sep-20	5	CO	57		3.2	1.73					0
ALE-MT07	20-Sep-20	5	CO	59		2.8	1.36					0
ALE-MT07	20-Sep-20	5	CO	59		2.5	1.22					0
ALE-MT07	20-Sep-20	5	CO	59		4.1	2.00					0
ALE-MT07	20-Sep-20	5	CO	83		7.1	1.24	SC	7	FC	7	1
ALE-MT03	20-Sep-20	1	CO	46		1.3	1.34					0
ALE-MT03	20-Sep-20	1	CO	49		1.5	1.27					0
ALE-MT03	20-Sep-20	1	CO	49		1.3	1.10					0
ALE-MT03	20-Sep-20	1	CO	50		1.4	1.12					0
ALE-MT03	20-Sep-20	1	CO	50		1.4	1.12					0
ALE-MT03	20-Sep-20	1	CO	52		1.4	1.00					0
ALE-MT03	20-Sep-20	1	CO	54		1.9	1.207					0
ALE-MT03	20-Sep-20	1	CO	54		1.9	1.207					0
ALE-MT03	20-Sep-20	1	CO	54		2.3	1.461					0
ALE-MT03	20-Sep-20	1	CO	60		2.5	1.157					0
ALE-MT03	20-Sep-20	1	CO	63		2.8	1.12					0
ALE-MT03	20-Sep-20	1	CO	64		3.0	1.144					0
ALE-MT03	20-Sep-20	1	CO	64		3.1	1.183	SC	6	FC	6	0
ALE-MT03	20-Sep-20	1	CO	65		2.9	1.056					0
ALE-MT03	20-Sep-20	1	CO	85		6.9	1.124					1
ALE-MT03	20-Sep-20	1	CO									
ALE-MT03	20-Sep-20	1	CO									
ALE-MT03	20-Sep-20	1	CO									
ALE-MT03	20-Sep-20	1	CO									
ALE-MT03	20-Sep-20	1	CO									
ALE-MT03	20-Sep-20	1	CO									
ALE-MT03	20-Sep-20	1	CO									
ALE-MT03	20-Sep-20	1	CO									
ALE-MT03	20-Sep-20	2	CO	55		1.7	1.022					0
ALE-MT03	20-Sep-20	2	CO	58		2.4	1.23					0
ALE-MT03	20-Sep-20	2	CO	59		2.4	1.169					0
ALE-MT03	20-Sep-20	2	CO	64		2.9	1.106					0
ALE-MT03	20-Sep-20	2	CO	67		2.9	0.964					0
ALE-MT03	20-Sep-20	2	CO	70		4.0	1.166	SC	3	FC	3	0
ALE-MT03	20-Sep-20	2	CO	73		4.2	1.08					1
ALE-MT03	20-Sep-20	2	CO	74		4.3	1.061					1
ALE-MT03	20-Sep-20	2	CO	74		4.7	1.16					1
ALE-MT03	20-Sep-20	2	CO	75		4.7	1.114					1
ALE-MT03	20-Sep-20	2	CO	80		5.0	0.977					1
ALE-MT03	20-Sep-20	2	CO	83		6.3	1.102					1
ALE-MT03	20-Sep-20	2	CO	84		6.10	1.029	SC	2	FC	2	1
ALE-MT03	20-Sep-20	2	CO	85		7.60	1.238					1
ALE-MT03	20-Sep-20	2	CO	85		6.60	1.075					1
ALE-MT03	20-Sep-20	2	CO	90		8.10	1.111	SC	4	FC	4	1
ALE-MT03	20-Sep-20	2	CT	77		4.60	1.008	SC	5	FC	5	1
ALE-MT03	20-Sep-20	2	CT	89		5.80	0.823	SC	1	FC	1	1
ALE-MT03	20-Sep-20	3	CO	81		6.70	1.261					1
ALE-MT03	20-Sep-20	3	CO									
ALE-MT03	20-Sep-20	3	CO									
ALE-MT03	20-Sep-20	3	CO									
ALE-MT03	20-Sep-20	3	CO									
ALE-MT03	20-Sep-20	3	CO									
ALE-MT03	20-Sep-20	3	CO									
ALE-MT03	20-Sep-20	3	CT	77		4.90	1.073					1
ALE-MT03	20-Sep-20	3	CT	120		16.20	0.938	SC	8	FC	8	2
ALE-MT03	20-Sep-20	4	CO	54								0
ALE-MT03	20-Sep-20	4	CO	54		1.90	1.207					0
ALE-MT03	20-Sep-20	4	CO	56		1.1	0.63					0
ALE-MT03	20-Sep-20	4	CO	70		4.10	1.195					0
ALE-MT03	20-Sep-20	4	CT	99		9.00	0.928					1

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (4 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT03	20-Sep-20	5	CO	47		1.30	1.252	SC	7	FC	7	0
ALE-MT03	20-Sep-20	5	CO	53		1.70	1.142					0
ALE-MT03	20-Sep-20	5	CO	55		2.00	1.202					0
ALE-MT03	20-Sep-20	5	CO	55		1.40	0.841					0
ALE-MT03	20-Sep-20	5	CO	56		1.90	1.082					0
ALE-MT03	20-Sep-20	5	CO	63		2.80	1.12					0
ALE-MT03	20-Sep-20	5	CO	79		5.00	1.014					1
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (5 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CO									
ALE-MT06	20-Sep-20	1	CT									
ALE-MT06	20-Sep-20	1	CT									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	1	CT									
ALE-MT06	20-Sep-20	1	CT									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (6 of 17).

Site	Date	Trap #	Species¹	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CO									
ALE-MT06	20-Sep-20	2	CT									
ALE-MT06	20-Sep-20	2	CT									
ALE-MT06	20-Sep-20	3	CO	48		2.20	1.989					0
ALE-MT06	20-Sep-20	3	CO	52		1.70	1.209					0
ALE-MT06	20-Sep-20	3	CO	57		2.00	1.08					0
ALE-MT06	20-Sep-20	3	CO	59		2.50	1.217					0
ALE-MT06	20-Sep-20	3	CO	80		5.50	1.074					1
ALE-MT06	20-Sep-20	3	CO		45							0
ALE-MT06	20-Sep-20	3	CO		50							0
ALE-MT06	20-Sep-20	3	CO		50							0
ALE-MT06	20-Sep-20	3	CO		55							0
ALE-MT06	20-Sep-20	3	CO		55							0
ALE-MT06	20-Sep-20	3	CO		55							0
ALE-MT06	20-Sep-20	3	CO		60							0
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									

¹ CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (7 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO									
ALE-MT06	20-Sep-20	3	CO		52							0
ALE-MT06	20-Sep-20	4	CO	52		2.60	1.849					0
ALE-MT06	20-Sep-20	4	CO	63		3.60	1.44					0
ALE-MT06	20-Sep-20	4	CO	78		5.50	1.159					1
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CO									
ALE-MT06	20-Sep-20	4	CT	55		1.90	1.142					0
ALE-MT06	20-Sep-20	4	CT	81		5.00	0.941	SC	10	FC	10	1
ALE-MT06	20-Sep-20	4	CT	128		18.30	0.873					2
ALE-MT06	20-Sep-20	5	CO	75		4.30	1.019					1
ALE-MT06	20-Sep-20	5	CO	80		5.70	1.113					1
ALE-MT06	20-Sep-20	5	CO	81		6.20	1.167					1
ALE-MT06	20-Sep-20	5	CO	81		5.50	1.035					1
ALE-MT06	20-Sep-20	5	CO	90		9.40	1.289					1
ALE-MT06	20-Sep-20	5	CO		45							0
ALE-MT06	20-Sep-20	5	CO		50							0
ALE-MT06	20-Sep-20	5	CO		50							0
ALE-MT06	20-Sep-20	5	CO		60							0
ALE-MT06	20-Sep-20	5	CO		65							0
ALE-MT06	20-Sep-20	5	CO		70							0
ALE-MT06	20-Sep-20	5	CO		70							0
ALE-MT06	20-Sep-20	5	CO		75							1
ALE-MT06	20-Sep-20	5	CO		75							1
ALE-MT06	20-Sep-20	5	CO		78							1
ALE-MT06	20-Sep-20	5	CO		78							1
ALE-MT06	20-Sep-20	5	CO		80							1
ALE-MT06	20-Sep-20	5	CO		85							1
ALE-MT06	20-Sep-20	5	CO		85							1
ALE-MT06	20-Sep-20	5	CO		90							1

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (8 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT06	20-Sep-20	5	CO		90							1
ALE-MT06	20-Sep-20	5	CO		90							1
ALE-MT06	20-Sep-20	5	CO		90							1
ALE-MT06	20-Sep-20	5	CO		100							1
ALE-MT06	20-Sep-20	5	CO		100							1
ALE-MT06	20-Sep-20	5	CO		52							0
ALE-MT06	20-Sep-20	5	CO		72							0
ALE-MT06	20-Sep-20	5	CT		75							1
ALE-MT06	20-Sep-20	5	CT		80							1
ALE-MT06	20-Sep-20	5	CT	120		16.30	0.943					2
ALE-MT06	20-Sep-20	5	CT	120		17.10	0.99					2
ALE-MT06	20-Sep-20	9	CO	59		2.30	1.12					0
ALE-MT06	20-Sep-20	9	CO	60		2.50	1.157					0
ALE-MT06	20-Sep-20	9	CO	62		3.00	1.259					0
ALE-MT06	20-Sep-20	9	CO	70		3.60	1.05					0
ALE-MT06	20-Sep-20	9	CO	73		5.10	1.311					1
ALE-MT06	20-Sep-20	9	CO	75		4.90	1.161					1
ALE-MT06	20-Sep-20	9	CO	84		6.40	1.08					1
ALE-MT06	20-Sep-20	9	CO	86		7.20	1.132					1
ALE-MT06	20-Sep-20	9	CO	89		7.60	1.078					1
ALE-MT06	20-Sep-20	9	CO		80							1
ALE-MT06	20-Sep-20	9	CO		90							1
ALE-MT06	20-Sep-20	9	CO		82							1
ALE-MT06	20-Sep-20	9	CO		81							1
ALE-MT06	20-Sep-20	9	CO	92		8.30	1.066					1
ALE-MT06	20-Sep-20	9	CO	92		9.40	1.207					1
ALE-MT06	20-Sep-20	9	CT	94		8.60	1.035	SC	7	FC	7	1
ALE-MT06	20-Sep-20	9	CT	157		34.50	0.891	SC	5	FC	5	3
ALE-MT06	20-Sep-20	9	CT	140		27.30	0.995	SC	6	FC	6	2
ALE-MT06	20-Sep-20	10	CO	45		1.00	1.097					0
ALE-MT06	20-Sep-20	10	CO	45		0.80	0.878					0
ALE-MT06	20-Sep-20	10	CO	50		1.40	1.12					0
ALE-MT06	20-Sep-20	10	CO	52		2.00	1.422					0
ALE-MT06	20-Sep-20	10	CO	52		1.50	1.067					0
ALE-MT06	20-Sep-20	10	CO	58		2.20	1.128					0
ALE-MT06	20-Sep-20	10	CO	59		2.20	1.071					0
ALE-MT06	20-Sep-20	10	CO	69		4.30	1.309					0
ALE-MT06	20-Sep-20	10	CO	73		4.30	1.105					1
ALE-MT06	20-Sep-20	10	CO	74		4.50	1.11	SC	1	FC	1	1
ALE-MT06	20-Sep-20	10	CO	75		4.70	1.114					1
ALE-MT06	20-Sep-20	10	CO	76		4.80	1.093					1
ALE-MT06	20-Sep-20	10	CO	82		6.40	1.161					1
ALE-MT06	20-Sep-20	10	CO	84		6.00	1.012					1
ALE-MT06	20-Sep-20	10	CO	85		6.50	1.058					1
ALE-MT06	20-Sep-20	10	CO	90		8.40	1.152					1
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (9 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CO									
ALE-MT06	20-Sep-20	10	CT	103		11.20	1.025	SC	2	FC	2	1
ALE-MT06	20-Sep-20	7	CO	43		0.90	1.132					0
ALE-MT06	20-Sep-20	7	CO	44		1.00	1.174					0
ALE-MT06	20-Sep-20	7	CO	45		1.00	1.097					0
ALE-MT06	20-Sep-20	7	CO	45		0.90	0.988					0
ALE-MT06	20-Sep-20	7	CO	45		0.90	0.988					0
ALE-MT06	20-Sep-20	7	CO	46		1.00	1.027					0
ALE-MT06	20-Sep-20	7	CO	46		1.20	1.233					0
ALE-MT06	20-Sep-20	7	CO	47		1.00	0.963					0
ALE-MT06	20-Sep-20	7	CO	47		1.00	0.963					0
ALE-MT06	20-Sep-20	7	CO	48		1.30	1.175					0
ALE-MT06	20-Sep-20	7	CO	48		1.20	1.085					0
ALE-MT06	20-Sep-20	7	CO	50		1.30	1.04					0
ALE-MT06	20-Sep-20	7	CO	50		1.70	1.36					0
ALE-MT06	20-Sep-20	7	CO	51		1.30	0.98					0
ALE-MT06	20-Sep-20	7	CO	52		1.50	1.067					0
ALE-MT06	20-Sep-20	7	CO	52		1.40	0.996	SC	3	FC	3	0
ALE-MT06	20-Sep-20	7	CO	52		1.80	1.28					0
ALE-MT06	20-Sep-20	7	CO	53		1.70	1.142					0
ALE-MT06	20-Sep-20	7	CO	55		1.70	1.022					0
ALE-MT06	20-Sep-20	7	CO	59		1.70	0.828					0
ALE-MT06	20-Sep-20	7	CO	59		2.30	1.12					0
ALE-MT06	20-Sep-20	7	CO	62		2.60	1.091					0
ALE-MT06	20-Sep-20	7	CO	76		4.90	1.116					1
ALE-MT06	20-Sep-20	7	CO	80		6.00	1.172					1
ALE-MT06	20-Sep-20	7	CO	80		5.80	1.133					1
ALE-MT06	20-Sep-20	7	CO	80		5.60	1.094					1
ALE-MT06	20-Sep-20	7	CO	80		5.90	1.152					1
ALE-MT06	20-Sep-20	7	CO	81		6.40	1.204					1
ALE-MT06	20-Sep-20	7	CO	81		6.60	1.242					1
ALE-MT06	20-Sep-20	7	CO	82		6.30	1.143					1
ALE-MT06	20-Sep-20	7	CO	86								1
ALE-MT06	20-Sep-20	7	CO	86		7.20	1.132					1
ALE-MT06	20-Sep-20	7	CO	95		10.60	1.236	SC	4	FC	4	1
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	7	CO									
ALE-MT06	20-Sep-20	8	CO	52								0
ALE-MT06	20-Sep-20	8	CO	65		3.10	1.129	SC	9	FC	9	0
ALE-MT06	20-Sep-20	8	CO	69		4.30	1.309					0
ALE-MT06	20-Sep-20	8	CO	76		7.00	1.595					1
ALE-MT06	20-Sep-20	8	CO	78		5.30	1.117					1
ALE-MT06	20-Sep-20	8	CO	79		5.70	1.156					1
ALE-MT06	20-Sep-20	8	CO	80		5.50	1.074					1

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (10 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT06	20-Sep-20	8	CO	82		7.80	1.415					1
ALE-MT06	20-Sep-20	8	CO	83		6.10	1.067					1
ALE-MT06	20-Sep-20	8	CO	84		5.90	0.995					1
ALE-MT06	20-Sep-20	8	CO									
ALE-MT06	20-Sep-20	8	CO									
ALE-MT06	20-Sep-20	8	CO									
ALE-MT06	20-Sep-20	8	CO									
ALE-MT06	20-Sep-20	8	CO									
ALE-MT06	20-Sep-20	8	CO									
ALE-MT06	20-Sep-20	8	CT	150		32.0	0.95	SC	8	FC	8	3
ALE-MT06	20-Sep-20	6	CO		50							0
ALE-MT06	20-Sep-20	6	CO		50							0
ALE-MT06	20-Sep-20	6	CO		60							0
ALE-MT06	20-Sep-20	6	CO		70							0
ALE-MT06	20-Sep-20	6	CO		75							1
ALE-MT06	20-Sep-20	6	CO		75							1
ALE-MT06	20-Sep-20	6	CO		80							1
ALE-MT06	20-Sep-20	6	CO		80							1
ALE-MT06	20-Sep-20	6	CO		80							1
ALE-MT06	20-Sep-20	6	CO		85							1
ALE-MT06	20-Sep-20	6	CO		90							1
ALE-MT06	20-Sep-20	6	CO		90							1
ALE-MT06	20-Sep-20	6	CO		90							1
ALE-MT06	20-Sep-20	6	CO		95							1
ALE-MT06	20-Sep-20	6	CO		100							1
ALE-MT06	20-Sep-20	6	CO		110							1
ALE-MT06	20-Sep-20	6	CO		110							1
ALE-MT06	20-Sep-20	6	CO		110							1
ALE-MT06	20-Sep-20	6	CO									
ALE-MT06	20-Sep-20	6	CO									
ALE-MT06	20-Sep-20	6	CO									
ALE-MT06	20-Sep-20	6	CO									
ALE-MT06	20-Sep-20	6	CO									
ALE-MT06	20-Sep-20	6	CO									
ALE-MT06	20-Sep-20	6	CO									
ALE-MT06	20-Sep-20	6	CO									
ALE-MT06	20-Sep-20	6	CO		52							0
ALE-MT06	20-Sep-20	6	CT		110							1
ALE-MT06	20-Sep-20	6	CT	160		36.7	0.90					3
ALE-MT08	20-Sep-20	1	CO	45		1.3	1.43					0
ALE-MT08	20-Sep-20	1	CO	50		1.8	1.44					0
ALE-MT08	20-Sep-20	1	CO	51		1.7	1.28					0
ALE-MT08	20-Sep-20	1	CO	51		1.8	1.36					0
ALE-MT08	20-Sep-20	1	CO	55		2.0	1.20					0
ALE-MT08	20-Sep-20	1	CO	55		2.1	1.26					0
ALE-MT08	20-Sep-20	1	CO	60		2.9	1.34					0
ALE-MT08	20-Sep-20	1	CO	61		3.5	1.54					0
ALE-MT08	20-Sep-20	1	CO	62								0
ALE-MT08	20-Sep-20	1	CO	62		3.2	1.34					0
ALE-MT08	20-Sep-20	1	CO	65		3.6	1.31					0
ALE-MT08	20-Sep-20	1	CO	85		7.0	1.14					1
ALE-MT08	20-Sep-20	1	CO	88		8.4	1.23	SC	1	FC	1	1
ALE-MT08	20-Sep-20	1	CO		50							0
ALE-MT08	20-Sep-20	1	CO		50							0
ALE-MT08	20-Sep-20	1	CO		50							0
ALE-MT08	20-Sep-20	1	CO		50							0
ALE-MT08	20-Sep-20	1	CO		54							0
ALE-MT08	20-Sep-20	1	CO		60							0
ALE-MT08	20-Sep-20	1	CO		60							0
ALE-MT08	20-Sep-20	1	CO		65							0

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (11 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT08	20-Sep-20	1	CO		65							0
ALE-MT08	20-Sep-20	1	CO		65							0
ALE-MT08	20-Sep-20	1	CO		70							0
ALE-MT08	20-Sep-20	1	CO		80							1
ALE-MT08	20-Sep-20	1	CO		85							1
ALE-MT08	20-Sep-20	1	CO		85							1
ALE-MT08	20-Sep-20	1	CO		90							1
ALE-MT08	20-Sep-20	1	CO		100							1
ALE-MT08	20-Sep-20	2	CO	51		1.5	1.13	SC	3	FC	3	0
ALE-MT08	20-Sep-20	2	CO	90		8.6	1.18	SC	4	FC	4	1
ALE-MT08	20-Sep-20	2	CO		45							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		50							0
ALE-MT08	20-Sep-20	2	CO		55							0
ALE-MT08	20-Sep-20	2	CO		60							0
ALE-MT08	20-Sep-20	2	CO		60							0
ALE-MT08	20-Sep-20	2	CO		70							0
ALE-MT08	20-Sep-20	2	CO		80							1
ALE-MT08	20-Sep-20	2	CO		80							1
ALE-MT08	20-Sep-20	2	CO		85							1
ALE-MT08	20-Sep-20	2	CT	75		4.10	0.972	SC	5	FC	5	1
ALE-MT08	20-Sep-20	2	CT		90							1
ALE-MT08	20-Sep-20	3	CO	79		5.50	1.116	SC	2	FC	2	1
ALE-MT08	20-Sep-20	3	CO		50							0
ALE-MT08	20-Sep-20	3	CO		55							0
ALE-MT08	20-Sep-20	3	CO		60							0
ALE-MT08	20-Sep-20	3	CO		60							0
ALE-MT08	20-Sep-20	3	CO		65							0
ALE-MT08	20-Sep-20	3	CO		70							0
ALE-MT08	20-Sep-20	3	CO		70							0
ALE-MT08	20-Sep-20	3	CO		70							0
ALE-MT08	20-Sep-20	3	CO		70							0
ALE-MT08	20-Sep-20	3	CO		70							0
ALE-MT08	20-Sep-20	3	CO		75							1
ALE-MT08	20-Sep-20	3	CO		75							1
ALE-MT08	20-Sep-20	3	CO		75							1
ALE-MT08	20-Sep-20	3	CO		75							1
ALE-MT08	20-Sep-20	3	CO		77							1
ALE-MT08	20-Sep-20	3	CO		80							1
ALE-MT08	20-Sep-20	3	CO		80							1
ALE-MT08	20-Sep-20	3	CO		85							1
ALE-MT08	20-Sep-20	3	CO		90							1
ALE-MT08	20-Sep-20	3	CO		90							1
ALE-MT08	20-Sep-20	3	CO		95							1
ALE-MT08	20-Sep-20	3	CO		95							1
ALE-MT08	20-Sep-20	3	CO		100							1
ALE-MT08	20-Sep-20	4	CO		50							0
ALE-MT08	20-Sep-20	4	CO		70							0
ALE-MT08	20-Sep-20	4	CO		75							1
ALE-MT08	20-Sep-20	4	CO		80							1
ALE-MT08	20-Sep-20	4	CO		80							1
ALE-MT08	20-Sep-20	4	CO		85							1
ALE-MT08	20-Sep-20	4	CO		85							1

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (12 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT08	20-Sep-20	4	CO		85							1
ALE-MT08	20-Sep-20	4	CO		90							1
ALE-MT08	20-Sep-20	4	CO		95							1
ALE-MT08	20-Sep-20	4	CO		95							1
ALE-MT08	20-Sep-20	4	CO		100							1
ALE-MT08	20-Sep-20	5	CO		45							0
ALE-MT08	20-Sep-20	5	CO		50							0
ALE-MT08	20-Sep-20	5	CO		50							0
ALE-MT08	20-Sep-20	5	CO		55							0
ALE-MT08	20-Sep-20	5	CO		60							0
ALE-MT08	20-Sep-20	5	CO		60							0
ALE-MT08	20-Sep-20	5	CO		60							0
ALE-MT08	20-Sep-20	5	CO		65							0
ALE-MT08	20-Sep-20	5	CO		70							0
ALE-MT08	20-Sep-20	5	CO		75							1
ALE-MT08	20-Sep-20	5	CO		78							1
ALE-MT08	20-Sep-20	5	CO		78							1
ALE-MT08	20-Sep-20	5	CO		80							1
ALE-MT08	20-Sep-20	5	CO		90							1
ALE-MT08	20-Sep-20	5	CO		90							1
ALE-MT08	20-Sep-20	5	CO		90							1
ALE-MT08	20-Sep-20	5	CO		95							1
ALE-MT08	20-Sep-20	5	CO		95							1
ALE-MT08	20-Sep-20	5	CO		100							1
ALE-MT08	20-Sep-20	5	CO		110							1
ALE-MT08	20-Sep-20	5	CT		80							1
ALE-MT09	20-Sep-20	1	CO		60							0
ALE-MT09	20-Sep-20	1	CO		70							0
ALE-MT09	20-Sep-20	1	CO		80							1
ALE-MT09	20-Sep-20	1	CO		90							1
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CO									
ALE-MT09	20-Sep-20	1	CT		100							1
ALE-MT09	20-Sep-20	1	CT		130							2
ALE-MT09	20-Sep-20	2	CO		45							0
ALE-MT09	20-Sep-20	2	CO		50							0
ALE-MT09	20-Sep-20	2	CO		50							0
ALE-MT09	20-Sep-20	2	CO		60							0
ALE-MT09	20-Sep-20	2	CO		60							0
ALE-MT09	20-Sep-20	2	CO		60							0
ALE-MT09	20-Sep-20	2	CO		65							0
ALE-MT09	20-Sep-20	2	CO		65							0

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (13 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT09	20-Sep-20	2	CO		70							0
ALE-MT09	20-Sep-20	2	CO		70							0
ALE-MT09	20-Sep-20	2	CO		75							1
ALE-MT09	20-Sep-20	2	CO		75							1
ALE-MT09	20-Sep-20	2	CO		80							1
ALE-MT09	20-Sep-20	2	CO		90							1
ALE-MT09	20-Sep-20	2	CT		50							0
ALE-MT09	20-Sep-20	2	CT		70							1
ALE-MT09	20-Sep-20	2	CT		80							1
ALE-MT09	20-Sep-20	2	CT		100							1
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	3	CO									
ALE-MT09	20-Sep-20	4	CO		50							0
ALE-MT09	20-Sep-20	4	CO		50							0
ALE-MT09	20-Sep-20	4	CO		50							0
ALE-MT09	20-Sep-20	4	CO		55							0
ALE-MT09	20-Sep-20	4	CO		55							0
ALE-MT09	20-Sep-20	4	CO		60							0
ALE-MT09	20-Sep-20	4	CO		60							0
ALE-MT09	20-Sep-20	4	CO		60							0
ALE-MT09	20-Sep-20	4	CO		65							0
ALE-MT09	20-Sep-20	4	CO		65							0
ALE-MT09	20-Sep-20	4	CO		68							0
ALE-MT09	20-Sep-20	4	CO		70							0
ALE-MT09	20-Sep-20	4	CO		75							1
ALE-MT09	20-Sep-20	4	CO		80							1
ALE-MT09	20-Sep-20	4	CO		85							1
ALE-MT09	20-Sep-20	4	CO		85							1
ALE-MT09	20-Sep-20	4	CO		90							1
ALE-MT09	20-Sep-20	4	CT		70							1
ALE-MT09	20-Sep-20	4	CT		95							1
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (14 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CO									
ALE-MT09	20-Sep-20	5	CT									
ALE-MT05	20-Sep-20	1	CO	85		6.9	1.12	SC	1	FC	1	1
ALE-MT05	20-Sep-20	1	CO		40							0
ALE-MT05	20-Sep-20	1	CO		50							0
ALE-MT05	20-Sep-20	1	CO		50							0
ALE-MT05	20-Sep-20	1	CO		60							0
ALE-MT05	20-Sep-20	1	CO		60							0
ALE-MT05	20-Sep-20	1	CO		60							0
ALE-MT05	20-Sep-20	1	CO		60							0
ALE-MT05	20-Sep-20	1	CO		65							0
ALE-MT05	20-Sep-20	1	CO		65							0
ALE-MT05	20-Sep-20	1	CO		65							0
ALE-MT05	20-Sep-20	1	CO		70							0
ALE-MT05	20-Sep-20	1	CO		70							0
ALE-MT05	20-Sep-20	1	CO		70							0
ALE-MT05	20-Sep-20	1	CO		70							0
ALE-MT05	20-Sep-20	1	CO		70							0
ALE-MT05	20-Sep-20	1	CO		73							1
ALE-MT05	20-Sep-20	1	CO		75							1
ALE-MT05	20-Sep-20	1	CO		80							1
ALE-MT05	20-Sep-20	1	CO		80							1
ALE-MT05	20-Sep-20	1	CO		80							1
ALE-MT05	20-Sep-20	1	CO		80							1
ALE-MT05	20-Sep-20	1	CO		80							1
ALE-MT05	20-Sep-20	1	CO		85							1
ALE-MT05	20-Sep-20	1	CO		85							1
ALE-MT05	20-Sep-20	1	CO		85							1
ALE-MT05	20-Sep-20	1	CO		85							1
ALE-MT05	20-Sep-20	1	CO		85							1
ALE-MT05	20-Sep-20	1	CO		85							1
ALE-MT05	20-Sep-20	1	CO		90							1
ALE-MT05	20-Sep-20	1	CO		90							1
ALE-MT05	20-Sep-20	1	CO		90							1
ALE-MT05	20-Sep-20	1	CO		90							1
ALE-MT05	20-Sep-20	1	CO		90							1
ALE-MT05	20-Sep-20	1	CO		90							1
ALE-MT05	20-Sep-20	1	CO		90							1
ALE-MT05	20-Sep-20	1	CO		90							1
ALE-MT05	20-Sep-20	1	CO		95							1
ALE-MT05	20-Sep-20	1	CO		95							1
ALE-MT05	20-Sep-20	1	CO		95							1
ALE-MT05	20-Sep-20	1	CO		95							1
ALE-MT05	20-Sep-20	1	CO		95							1

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (15 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT05	20-Sep-20	1	CO		95							1
ALE-MT05	20-Sep-20	1	CO		95							1
ALE-MT05	20-Sep-20	1	CO		100							1
ALE-MT05	20-Sep-20	1	CO		100							1
ALE-MT05	20-Sep-20	1	CO		100							1
ALE-MT05	20-Sep-20	2	CO	51		1.40	1.055	SC	3	FC	3	0
ALE-MT05	20-Sep-20	2	CO		50							0
ALE-MT05	20-Sep-20	2	CO		50							0
ALE-MT05	20-Sep-20	2	CO		60							0
ALE-MT05	20-Sep-20	2	CO		65							0
ALE-MT05	20-Sep-20	2	CO		65							0
ALE-MT05	20-Sep-20	2	CO		65							0
ALE-MT05	20-Sep-20	2	CO		70							0
ALE-MT05	20-Sep-20	2	CO		80							1
ALE-MT05	20-Sep-20	2	CO		85							1
ALE-MT05	20-Sep-20	2	CO		90							1
ALE-MT05	20-Sep-20	2	CO		90							1
ALE-MT05	20-Sep-20	2	CO		95							1
ALE-MT05	20-Sep-20	2	CO		100							1
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (16 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	2	CO									
ALE-MT05	20-Sep-20	3	CO									
ALE-MT05	20-Sep-20	3	CO									
ALE-MT05	20-Sep-20	3	CO									
ALE-MT05	20-Sep-20	3	CO									
ALE-MT05	20-Sep-20	3	CO									
ALE-MT05	20-Sep-20	3	CT									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Table 2. Continued (17 of 17).

Site	Date	Trap #	Species[1]	Measured Fork Length (mm)	Estimated Fork Length (mm)	Weight (g)	K	Age Sample Type	Age Sample Number	DNA Sample Type	DNA Sample Numer	Age Assigned
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	4	CO									
ALE-MT05	20-Sep-20	5	CO	105		11.50	0.993	SC	2	FC	2	1
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									
ALE-MT05	20-Sep-20	5	CO									

[1] CO = Coho Salmon, CT = Cutthroat Trout, BT = Bull Trout, NFC = No Fish Captured.

Appendix B. Hedberg Vegetation Monitoring Report

Upper Lillooet Hydro Project
Revegetation Assessment Report for the Operational Environmental Monitoring Plan (OEMP)
Year 3 - 2020 Monitoring Year

Prepared for:

Upper Lillooet River Power Limited Partnership and Boulder Creek Limited Partnership
888 Dunsmuir Street, Suite 1100
Vancouver, BC V6C 3K4

Submitted by:

Hedberg and Associates Consulting Ltd.
205 - 1121 Commercial Way
Squamish, BC V8B 0S5

March 1, 2021

Published by Hedberg and Associates Consulting Ltd., Suite 205 – 1121 Commercial Place, Squamish, BC, V8B 0S5

Citation:

Johnston, C. 2020 Upper Lillooet Hydro Project: Revegetation Assessment Report for the Operational Environmental Monitoring Plan (OEMP), Year 3 - 2020 Monitoring Year. Consultant's report prepared for Upper Lillooet River Power Limited Partnership and Boulder Creek Limited Partnership, Vancouver, BC.

Codie Johnston, RFT #2007

Michael Hedberg RPF #2912

Senior Review

Disclaimer:

Hedberg and Associates Consulting Ltd. (Hedberg and Associates) prepared this report for Upper Lillooet River Power Limited Partnership and Boulder Creek Limited Partnership. The material in it reflects the professional judgment of Hedberg and Associates in light of the information available to Hedberg and Associates at the time of report preparation. Judgment has been applied in developing the recommendations in this report. No other warranty is made, either expressed or implied to our clients, third parties, and any regulatory agencies that may be impacted by the recommendations. Any use, which a Third Party makes of this report, or any reliance on decisions based on it, is the responsibility of such Third Parties. Hedberg and Associates accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

As a mutual protection to our client, the public and ourselves, all reports and drawings are submitted for the confidential information of our client for a specific project and authorization for use and/or publication of data, statements, conclusions or abstracts from or regarding our reports and drawings is reserved pending our written approval.

Table of Contents

List of Figures

List of Tables

List of Appendices

1. Introduction

The Upper Lillooet Hydro Project (ULHP) is owned and operated by the Upper Lillooet River Power Limited Partnership and Boulder Creek Power Limited Partnership (collectively, the Partnerships). The project is comprised of two run-of-river hydroelectric facilities, the largest of which is located on the mainstem of the Upper Lillooet River and a second facility located on Boulder Creek.

As a condition of the Project's Conditional Water License, Environmental Assessment Certificate, General Wildlife Measure Exemption Approvals and *Fisheries Act* Authorization, an Operational Environmental Management Plan (OEMP) was finalized in March 2017 (Harwood et al, 2017). One of the requirements within the OEMP was to complete long-term vegetation monitoring of sites that were disturbed and rehabilitated following project construction.

Hedberg and Associates Consulting Ltd. (HAC) is being retained by the Partnerships to complete the vegetation monitoring requirements of the OEMP. The requirements pertaining to revegetation works are described in Section 3.3 of the OEMP and are the basis for the works described in this report (see also Section 0 below).

This report summarizes the results of the revegetation assessment program for the 2020 monitoring year (Year 3 - 2020).

This report contains the following sections:

- the scope of the revegetation monitoring program (Section 0);
- a summary of source documents pertaining to restoration works (Section 0);
- the objectives of the revegetation program (Section 0);
- the 2020 data collection methods and field program details (Section 0);
- the results of the data collection from the 2020 monitoring program (Section 0); and
- the conclusions and recommendations regarding Year 3 (2020) monitoring (Section 7).

2. Scope of the Revegetation Monitoring Program

The scope of work for the year 3 revegetation monitoring program has followed the requirements of the OEMP (Harwood *et al.*, 2017). This includes the data collection, analysis and reporting of Section 3.3 "Vegetation Monitoring Requirements" of the OEMP. This report summarizes and compares the data collected in 2018 (Year 1 of the OEMP program) and 2020 (Year 3 of the OEMP program).

Monitoring for the 2018 and 2020 programs was carried out on two types of revegetation sites: transmission line sites and civil works sites. This will be discussed in greater detail below. The scope of work for this report includes the data collection, analysis and reporting of the following components outlined in Section 3.2.1 Habitat Restoration and Section 3.3 Vegetation Monitoring Requirement of the ULHP OEMP (Harwood et al, 2017):

- Section 3.3 - Vegetation Monitoring Requirements (including Table 27 and 28)
    - Vegetation Restoration Monitoring
    - Invasive Plant Monitoring
- Subcomponent of Section 3.2.1.3 - Wildlife Habitat Restoration, specifically the requirement to ensure the following:
    - Grizzly Bear habitat (subcomponent of Table 14 & 20)

        - At least 50% of the planted stems within the revegetated portion of the Grizzly Bear WHA 2-399 are native fruit bearing shrubs (Appendix A of the OEMP);
        - temporary roads or access tracks within WHA 2-399 are deactivated and non-drivable with an ATV.
    - Moose habitat (subcomponent of Table 14 & 21)
        - At least 50% of the planted stems within the revegetated portion of the Moose UWR, away from road verges, are preferred Moose forage species (Appendix A of the OEMP).
    - Mule Deer habitat (subcomponent of Table 14 & 22)
        - Revegetated portion of the Deer UWR were planted with native species.

Note: Other vegetation and/or habitat restoration assessments such as Aquatic and Riparian Habitat (Revegetation Assessment) (Section 2.3 of the OEMP) and the larger Wildlife Habitat Restoration (Section 3.2 of the OEMP) except for what is noted above are outside the scope of this report.

The OEMP (Harwood *et al*., 2017) requires that vegetation and invasive plants be monitored annually for the first five years of the Project, except for riparian vegetation monitoring, which is only required in Years 1, 3 and 5. A revised OEMP recommended reducing the frequency of the non-riparian vegetation monitoring and invasive plants to match the frequency of the riparian vegetation monitoring (i.e. Years 1, 3 and 5 instead of Years 1 through 5) in their letter titled "Upper Lillooet Hydro Project Updated Operational Environmental Monitoring Plan" (Faulkner *et al*. 2018). Specifically, the letter states the following regarding the proposed change to vegetation monitoring frequency:

"This change is recommended based on our monitoring of revegetation succession on similar projects and the observation that progress does not change substantially in a single year. Monitoring revegetation success can therefore be effectively determined by monitoring in the beginning, middle and end of a monitoring program." Furthermore, "frequency and/or duration of vegetation restoration monitoring will vary depending on revegetation success. Hence, if concerns are identified additional monitoring and/or management actions may be required" (Faulkner *et al.* 2018, p 10-11). Similar to the vegetation restoration component, Ecofish also recommends changing the frequency of "the invasive plants monitoring program [to] years 1,3, and 5 concurrent with the vegetation restoration component" (Faulkner *et al.* 2018, p. 11).

The letter along with a revised version of the OEMP (dated February 8, 2018) was submitted to MFLNRORD for review in February, 2018 and approval to reduce the frequency of monitoring was received by MFLNRORD on Sept 26, 2019 (T Katamay-Smith, pers comms). It is our recommendation at HAC that the program proceed with Year 5 of monitoring for both the vegetation and invasive plant monitoring as previously detailed in Ecofish's letter (Faulkner *et al.* 2018).

3. Revegetation/ Restoration Works Source Documents

Revegetation and restoration work for the ULHP were completed between 2016 and 2018 by the subcontractors for the ULHP (Westpark Electric Ltd. and CRT-ebc) as well as by the Partnerships. The restoration works for the civil works sites were completed by CRT-ebc and the Partnerships. The transmission line sites were rehabilitated by Westpark Electric Ltd. In general, restoration works consisted of a variety of treatments including soil rehabilitation/ decompaction, topsoil replacement, slope re-contouring, coarse woody debris placement, grass seeding and replanting with a variety of shrub and/or trees. This report does not detail the restoration measures that have been implemented, but for reference, restoration works and post-revegetation inspections can be found in the following reports:

- Upper Lillooet Hydro Master Reclamation Work Plan, BC unpublished report prepared for Ian McKeachie, Environmental Manager, CRT-EBC Construction, Upper Lillooet Hydro Project (McKeachie, 2016)
- Restoration Progress at Upper Lillooet Power Project (Polster, 2016)
- Works Plan for Transmission Line Access Roads Deactivation and Rehabilitation - North Zone, March 10, 2016 (Barker & Guilbride 2016)
- Works Plan for Transmission Line Access Roads Deactivation and Rehabilitation - South Zone (Barker & Guilbride 2016)
- Memorandum prepared for Robert Taylor, Westpark Electric Ltd. October 13, 2017 Re: Inspection of completed deactivation and rehabilitation works, Upper Lillooet Power Project transmission line, North Zone (Guilbride 2017)
- Memorandum prepared for Robert Taylor, Westpark Electric Ltd. August 7, 2017 Re: Inspection of completed deactivation and rehabilitation works, Upper Lillooet Power Project transmission line, North Zone (Guilbride 2017)
- Memorandum prepared for Robert Taylor, Westpark Electric Ltd. October 3, 2017 Re: Inspection of completed deactivation and rehabilitation works, Upper Lillooet Power Project transmission line, South Zone (Guilbride 2017)
- Memorandum prepared for Tanya Katamay-Smith, the Partnerships. March 26, 2019 Re: Reforestation summary of October 2018 tree planting for civil works sites at the Upper Lillooet Hydroelectric Project (Barker 2019)

4. Objectives of Revegetation Program

4.1 Long-term Revegetation Goals

As per Section 3.3 of the OEMP, the objectives of the long-term vegetation monitoring program are to "qualify and quantify the re-growth of vegetation in terrestrial and riparian areas to mitigate the short-term habitat loss and to prevent the introduction of invasive species that may occur through site disturbance" (Harwood et al. 2017).

An additional project objective is:

"to assist the recovery of disturbed areas towards reaching a desired future condition that is self-sustaining and capable of supporting soils, soil function and vegetation communities and processes similar to the adjacent undeveloped areas with no subsequent management inputs required" (Soil Salvage, Site Reclamation and Landscape Restoration Plan, Barker 2012).

Lastly, during the Environmental Assessment process, it was identified that the ULHP will affect forest resource values, and in this case, the Timber Harvesting Land Base (Hedberg Associates, 2011). In order to minimize these effects, it was identified in the forestry baseline assessment that reforestation plans would be developed to return the land base, wherever practicable, "*similar to the adjacent undeveloped areas*" by replanting with coniferous species or mixed forests to achieve forest objectives.

This monitoring program is part of the overall plan to achieve these revegetation/ reforestation goals and is designed in accordance with the OEMP and all ULHP related documentation.

4.2 Short-term Revegetation Goals

In the first 5 years following planting and during the OEMP monitoring period, the goal is to have strong survival of a diversity of natural and planted herb, shrub and tree species. The community begins with relatively few pioneering plant species and develops through increasing complexity until it becomes stable or self-sustaining over time.

A restored site would consist of vigorous and healthy plant communities, with a diversity of herbs, shrubs, and trees that have become established and are growing well. Additional site indicators for a successful site would include a stable slope shape, coarse woody debris of various sizes present on the landscape, and no siltation or major erosion issues.

Following the implementation of the revegetation treatment in combination with natural recovery processes, it is expected that the following will occur over the next decade:

- Continued growth and infill of planted and naturally seeded vegetation;
- Soil development processes and improved soil moisture holding capacity will continue to occur over time;
- Restoration of wildlife habitat providing wildlife forage areas, security and thermal cover areas; and
- Increased habitat connectivity between adjacent undisturbed areas and treated areas.

4.3 Site-specific Revegetation Goals

As mentioned above, there are some additional project specific OEMP requirements (Harwood et al. 2017) and they include:

1. At least 50% of the planted stems within the revegetated portion of the grizzly bear Wildlife Habitat Area (WHA) 2-399 are native fruit bearing shrubs.
2. Temporary roads or access tracks within WHA 2-399 are deactivated and non-drivable with an ATV.
3. At least 50% of the planted stems within the revegetated portion of the moose Ungulate Winter Range (UWR), away from road verges, are preferred moose forage species.
4. That the revegetated portion of the deer UWR are planted with native species.

5. 2020 Revegetation Monitoring Program and Data Collection Methods

The 2020 monitoring program was carried out by team lead Codie Johnston RFT. Codie Johnston is a BC Certified Accredited Silviculture Surveyor #AA2006008 with 17 years of plant identification experience. Other staff members of Hedberg and Associates who worked on the data collection phase of the project are Rachel Amundsen FIT and Nick Seymour RPF. Rachel Amundsen is a Certified Accredited Silviculture Surveyor #AA2020036 and has 3 years of plant identification experience. Nick Seymour has 1 year of plant identification experience. Both Rachel and Nick's roles included the identification of conifer, deciduous, shrub and herbaceous species as well as collecting percent cover of trees, shrubs and herbs in the quadrat surveys. When Rachel and Nick were available to collect field data they worked as a team with Codie Johnston. The fieldwork for the 2020 monitoring program was carried out in July and October of 2020.

To evaluate the areas that were revegetated and or restored by the Partnerships or their subcontractors, revegetation monitoring plots were permanently established throughout the treated areas. Treated areas consist of both civil works sites and the transmission line sites. On the transmission line sites, the post-construction revegetation works were completed prior to the 2018 survey; however, on the civil works sites, the majority of sites were planted with additional conifers in October 2018.

Plot data collection and success reporting followed a methodology similar to the process used for assessing commercial tree stocking on harvested areas (BC silviculture stocking survey procedure – FS658). Plot information collected includes the number of planted/ natural woody stems present within the plot area and the density (% cover) and average heights of existing natural non-commercial and brush species that are contributing to revegetation of the sites. Professional judgement and quantifiable results of data collected in the fixed radius plots were utilized to determine if revegetation objectives are being met in Year 3 and are trending towards being met in Year 5 (the final monitoring year). The details of the revegetation success results will be described in Sections 6 of this document.

A minimum of one plot per site was established on sites smaller than one hectare (ha). For areas greater than one ha, one plot/ha was used to evaluate a given site (also called stratum on the data collection cards in Appendix B, C and D). Each fixed radius plot measured 3.99 m in radius or 50 m^2 in area. Plots were established at sites that will not be subject to future vegetation management efforts (i.e. areas outside of the limits of approach of the powerline) to represent areas that will remain stable throughout all of the monitoring years.

For very small road spurs (less than 0.4 hectares) that had high levels of early revegetation success, inspection points were taken as opposed to setting up permanent monitoring plots. Typically, inspection points were along spur roads where no major clearing efforts occurred, but rather a low impact machine (small excavator with wheels as opposed to tracks) was used to access the power pole. This resulted in very low overall impacts to soils and/or existing plants on those areas. The inspection sites were revisited in 2020 and are all continue to increase in diversity and stems per hectare. Many of the sites have completely recovered and are no longer identifiable as access points.

The monitoring used to evaluate the growth and survivorship of the natural and planted vegetation was achieved through three approaches:

1. sampling of permanent revegetation monitoring plots to quantify the stem densities of trees and shrubs.
2. placing quadrats to assess the percentage of vegetation ground cover in each layer (herb, shrub and tree layer); and
3. comparison of photographs taken at a similar angle and location to qualitatively document changes in vegetation and site conditions over time.

Additional information collected at each monitoring plot and inspection site included describing:

- erosion or siltation issues;
- coarse woody debris presence;
- whether wildlife-specific requirements were being met;
- evidence of disease or damage to plants;
- evidence of moss growth as an indicator of soil development processes; and
- invasive species presence.

5.1 Permanent Vegetation Density Monitoring Plots

In Year 1 (2018) of the overall monitoring program, circular permanent vegetation monitoring plots were established in the revegetation areas using a methodology similar to the process used to assess commercial tree stocking on harvested areas (BC silviculture stocking survey procedure – FS658). Each permanent plot area that was surveyed measured 3.99 m in radius, representing a total area of 50 m^2. Plots were pre-selected using a random GPS grid to avoid surveyor bias. See the maps in Appendix A for permanent monitoring plot locations. Each site had a minimum of 1 plot per hectare.

Within each plot, the surveyors counted the number of stems of each species of native perennial woody plant species. Perennially woody plant species include both shrubs and trees but excludes herbs and mosses. Each plant was identified and input into a computer program called "SNAP". Shrub and tree density values are then calculated in the office based on the number of live stems counted for each species multiplied over the given area.

No division was made between trees and/ or shrubs that were planted as opposed to those regenerated naturally; all planted and naturally regenerated species were counted in the same tally to measure overall vegetation growth. For accuracy and for repeatability of the process between years, stems were counted, as opposed to individual plants. Only stems that were rooted immediately adjacent to the soil surface were counted, as opposed to counting individual plants species with multiple stems. Individual shrubs are difficult to identify in the early phases of growth, as many shrubs have multiple stems from the soil surface interface (e.g. falsebox (*Paxistima myrsinites)*, salal *(Gaultheria shallon),* and many shrubs in the raspberry family (*Rubus spp.*)). Only live stems were counted in each plot in Year 1 (2018) and Year 3 (2020), this method will be replicated in Year 5 (2022). Where present invasive species were identified and recorded at each plot. Invasive species and treatments are discussed in Section 6.5 of this report.

5.1.1 Success Targets for Stem Densities

Stem density measurements will be collected as per the revised frequency proposed by Faulkner et al. (2018): Years 1, 3 and 5. The data collected regarding the density of each perennial woody species found will contribute the following critical information to the program:

1. Whether perennial woody species (shrubs and trees) are becoming denser or less dense over time. In a typical site, similar to one found at the ULHP, in the very early years, it is typical that shrub growth will increase rapidly over the first few years, but may decrease once the later successional species start to take hold at the site. Tree growth increases typically somewhat slower than shrubs and typically increases in density are on the order of 5-20 years for the sites/ typical species mixes that are found at the ULHP. In the first few years, it would be unlikely to see a high rate of conifer natural regeneration but typically by the end of the program, small conifer seedlings will be starting to establish. Measuring the densities will enable monitoring of any significant decreases, which may be indicative of a struggling site. Conversely, significant increases may indicate a need for thinning to reduce vegetation competing with conifer regeneration.
2. A list of the number and types of species found at each site. Knowing which species are found and how many different species are found at each site gives the assessor an understanding of the types of species being found (e.g. early colonizers versus climax species) and is an indicator of overall site diversity and resilience. The number of different species found is an important indicator of whether the diversity of the site is increasing or decreasing over time. For example,

an alder dominated site may become less diverse over time and a berry shrub type habitat may become more diverse over time. It is ideal to see a variety of species at a given site as this contributes to the natural resilience of each site.

Regarding the stem densities, the following comparisons will be included in subsequent monitoring years (Year 3 and 5):

1. A comparison of the density increases or decreases of shrubs and deciduous tree species
2. A comparison of the density increases or decreases of conifer tree species
3. A comparison the total number of species found
4. A comparison of the types of species found in each year (seral stage and climax species)

5.1.1.1 Shrubs and Deciduous Trees (Density Targets)

Due to the fact that a range of densities are desirable depending on the monitoring year, no quantitative stem density targets are recommended for shrubs and deciduous trees other than to monitor their increases or decreases over time. This is because the desired end goal for this variable is not linear, and sites can be healthy at a variety of stem densities as observed in the natural environment. In some stages of site regeneration, it may be desirable for areas to become denser, while at later stages, less dense sites are preferred to mimic natural succession processes. In addition, quantitative targets do not account for site specific biotic and abiotic variables. Instead, it is recommended that a site-specific approach be applied to each site to account for critical biotic and abiotic environmental factors. Each site will be assessed on a site-by-site basis to understand site trends and dynamics. Using this information, the Qualified Professional will determine on a site species basic whether treatments are required to meet overall project goals. Results from previous long-term vegetation monitoring programs have shown that using professional judgement is a valuable method incorporate a broad range of health factors that contribute to site vegetation establishment. Evidence over the past seven years on monitoring projects of a similar nature done by HAC showed that ecosystems can be healthy at a variety of densities and requires interpretation of the results as opposed to meeting pre-determined goal.

5.1.1.2 Conifer Tree Species (Density Targets)

For the conifer tree component, the recommended density target will be 1000 stems per hectare (sph) depending on the site. These densities have been recommended by the Registered Professional Forester (Wes Staven, RPF) assigned to this project. He has based this target on the ecology of the area, the biogeoclimatic zone, similar project success rates and other site-specific variables.

5.2 Percentage of Vegetation Cover Estimate (Quadrat monitoring)

For this project, total percentage of ground cover will be measured by layer (tree, shrub, and herb layer). To collect this metric, the surveyor placed a quadrat (a square frame with measured gradations) on the ground surface to measure the percentage of ground cover that is occupied by a given plant layer (herb, shrub and tree layer). Herb is a general term that includes forb (non woody plants with broader leaves and distinct flowers), ferns and fern allies, grasses, and sedges. The quadrat used for these surveys measured 1 m by 1 m. The quadrat is marked at regular intervals; each square of the quadrat represented 1% of the total area. In this case, each 10cm by 10cm of marked off area represented 1% of the total quadrat. For example, if there were five squares covered by shrub species

(3% of ground covered by thimbleberry and 2% of falsebox), then the surveyor would note that there was 5% cover in the shrub layer. This data was then input into the "SNAP" program on the iPad.

In total, two quadrat surveys were taken at each site. Each quadrat was placed on the north and east axis of the plot, 2.0 m away from the plot centre to avoid bias and increase repeatability between years. Each plant layer was grouped and measured as one unit. The layers are identified as 1) the herb layer, 2) the shrub layer and 3) the tree layer.

Determination of the average height for each species within each layer was completed through in-plot measurements of identified species.

Where present, total ground cover occupancy by moss species also was noted. For the moss layer an ocular estimate of total ground cover was completed. The cover attributed to moss does not contribute to the total cover calculations, rather it's provided to present evidence of ongoing soil development processes.

5.2.1 Success Targets for Percent Vegetation Cover

The target for success being measured is whether the percentage of ground cover for the later successional species (shrubs and trees) in each quadrat survey are increasing steadily throughout the monitoring period or reaching a steady state (i.e. not declining over time). Collecting percentage vegetation cover by layer will provide valuable data as to whether ecological succession processes are initiating. Using growth trends for the later successional species as the target is a good indicator to show whether succession is taking place or if mortality is occurring.

Targets for this measure will be met if the trend in each subsequent monitoring year for the shrub and tree layer is greater or equal to the previous monitoring year's percentage cover. If the trend is that the percent cover for the later successional species amounts are declining, then additional remedial measures will be considered.

5.3 Inspection Points

As explained in Section 5, for very small road spurs (less than 0.4 hectares) that had high levels of early revegetation success, inspection points were taken as opposed to setting up permanent monitoring plots. At each inspection point, the following data was collected:

- health and vigour of plant communities;
- erosion or siltation issues;
- coarse woody debris presence;
- notes on whether wildlife specific requirements were being met;
- evidence disease or damage to plants;
- evidence of moss growth as an indicator of soil development processes; and
- invasive species presence.

5.3.1 Success Targets for Inspection Points

Successful rehabilitation for each inspection point is defined in this report as a site that requires no further treatment to sustain plant growth and meet the long-term objectives of the OEMP and all project documentation. This will be based on qualitative observations of the data collected at each site (Section 5.3 above) and professional judgement of the surveyor.

5.4 Wildlife Specific Revegetation Requirements

As part of this monitoring program, there were additional wildlife-specific requirements associated with the revegetation program. The method used to evaluate compliance with the wildlife specific requirements included a field visit to each site located within designated Wildlife Habitat Areas (WHAs) and Ungulate Winter Ranges (UWR) and consisted of at least 1 visual plot per hectare. The visual plot entailed an ocular estimate that evaluated compliance within an area the size of a 3.99 m fixed radius plot. The plot was then assessed for compliance with the wildlife specific targets discussed below.

It is important to note that for the deer and moose UWRs, the majority of sites were under the transmission line and will be subject to future vegetation management efforts. Those sites were visited even if they were under the transmission line to evaluate compliance, however to maintain line security, those sites will be subject to alterations (e.g. thinning, pruning, tree felling, etc.) in the future. The sites found within grizzly bear WHA 2-399 were located adjacent to the forest service road (Upper Lillooet FSR South) and were evaluated for compliance with OEMP requirements; although, the berry shrub planting requirement is not recommended for areas within close proximity to road verges and is therefore considered not applicable to the sites studied within this report. This will be discussed further in Results: Section 0 below.

5.4.1 Success Targets within Grizzly Bear Wildlife Habitat Areas (WHA)

Within Grizzly Bear Wildlife Habitat Area (WHA 2-399), as mentioned above, the requirement is as follows: “at least 50% of the planted stems within the revegetated portion of the Grizzly Bear WHA 2-399 are native fruit bearing shrubs” (Appendix A of the Long Term Monitoring Program Report (LTMP)). This will be measured in each monitoring year (years 1, 3 and 5) to ensure that the fruit-bearing shrub component for each revegetated portion on any upland areas meets or exceeds this requirement. Additionally, temporary roads or access tracks within WHA 2-399 are required to be deactivated and non-drivable with an ATV. See Section 6.3.5 for the 2020 results.

5.4.2 Success Targets within Moose Ungulate Winter Range (UWR)

Within moose UWR, as per the OEMP, the following success target will be used within government established moose habitat: that “at least 50% of the planted stems within the revegetated portion of the Moose Ungulate Winter Range (UWR) away from road verges, are preferred moose forage species” (Appendix A of the LTMP). This requirement was field verified by the Surveyor in Year 1 and does not require future monitoring because it is a planting requirement not a long-term monitoring requirement.

5.4.3 Success Targets within Deer Ungulate Winter Range (UWR)

Within deer UWR, any revegetated portions of Deer Ungulate Winter Range will be measured for the following success target, that “the revegetated portion of the Deer UWR were planted with native species” (Appendix A of the LTMP). This was an ocular estimate carried out in the initial monitoring year (Year 1) to determine if this target has been met. This requirement was field verified by the Surveyor in Year 1 and does not require future monitoring because it is a planting requirement not a long-term monitoring requirement.

6. Results

The civil works site plot data collected in Year 3 (2020) has been separated into two categories to make it easier to summarize and compare the information. The first category includes all the sites that had permanent sample plots established in 2018 and for which data was collected in both Year 1 (2018) and Year 3 (2020). This data set is further separated by zones (see Appendix A: Maps of Project Revegetation Sites). At the end of each zone summary there are photos from 2018 and 2020 taken at each plot to show visual vegetation changes on the site. Plot data tables are also included. The tables compare the vegetation density (by stems per hectare) that was onsite in 2018 with the vegetation found in 2020. The tables display coniferous, deciduous and shrub diversity as well as the number of species present in 2018 and 2020.

The second category includes all the sites that were planted in the fall of 2018. Permanent sample plots were established on these sites in 2019 and 2020. These sites are summarized separately as a complete data set was only collected in 2020. The survey data collected in 2019 was to assess seedling survival one year after planting.

6.1 Results for Civil Works Sites with 2018 and 2020 Data

6.1.1 Zone 1 Results Summary

Zone 1 includes two sites - the 36 Km Borrow Pit and the Boulder Powerhouse, Spoil and Operators Residence. The 36 Km Borrow Pit and part of the Boulder Powerhouse sites were planted in 2017 with a mix of conifers and shrubs. The Boulder Powerhouse Spoil area in front of the operator's residence was planted in the fall of 2018. A second plot was established here in 2020 and is summarized with the civil works sites that were established in 2020.

The 36 km Borrow Pit is located on a gentle slope with sandy soils that are not too compact. The soils were fluffed up and coarse woody debris was scattered across the site. The area was planted with a mix of conifers in 2017. In 2018 there were 800 sph of Douglas fir growing onsite. There are other conifer species present but they were not picked up in our long-term monitoring plot. The number of Douglas fir has increased to 1200 sph in 2020. The increase in sph is due to natural ingress of Douglas fir seed from adjacent mature conifers. The planted and natural conifers are of good form and vigour and are free from any forest health concerns. The naturals are still quite small, ranging from 3 to 15 cm. The planted conifers have an average height of 35 cm. The number of deciduous sph has increased significantly from 2200 sph in 2018 to 9600 sph in 2020. The deciduous trees are growing vigorously onsite but are not impeding conifer growth at this time. In 2018 200 sph of shrub species were found in the plot. In 2020 this number increased to 600. This site is meeting the target of 1000 sph of conifers and increases in sph of both deciduous and shrub species indicates the site is successfully recovering. Moss cover is developing and is dependent on microtopography but will likely continue to increase. No evidence of erosion or siltation was noted.

The Boulder Powerhouse, Spoil and Operators Residence site has coarse gravel soils and is well drained. The original area adjacent to the powerhouse was planted with a mix of berry shrubs and conifers in 2017. When the operator's residence was built in 2018 further excavations were required and the size of the site was increased to accommodate the building activities. Both areas were planted with conifers in 2018. The number of conifers has increased from 600 sph in 2018 to 6000 in 2020. There has been lots of natural conifer ingress on this site from the adjacent mature stands. The number of black cottonwoods sph has increased from zero in 2018 to 24,000 in 2020. Many of these trees are still very small at less than 10 cm in height. The cottonwoods are not impeding conifer establishment at this time. The number of sph of shrubs and species diversity has increased significantly on this site. In 2018 there were 1000 sph and three species of shrubs present. In 2020 there were 11,400 sph and six species of shrubs. Red raspberry and thimbleberry had the greatest increase in number of sph. Moss cover is developing and is dependent on microtopography but will likely continue to increase. No evidence of erosion or siltation was noted.

Figure 1. Zone 1 Plot Photos from 2018 and 2020

Card: Civil Work
Stratum: 2018 36Km Borrow Pit/Plot: S/Comments
Overview photo looks South towards plot center. Oct 16, 2018 11.58.04 AM.jpg

Card: Civil Work
Stratum: 2020 36 Km Borrow Pit/Plot: S/Comments
Overview photo looks South from plot S.jpg

Card: Civil Work
Stratum: 2018 Boulder Powerhouse and Spoil/Plot: Q/Comments
Overview photo looks South towards plot center. Oct 15, 2018 12.07.35 PM.jpg

Card: Civil Work
Stratum: 2020 Boulder Powerhouse and Spoil/Plot: Q/Comments
Overview photo looks South from plot Q.jpg

Table 1. Zone 1 – Vegetation Density and Species Diversity from 2018 to 2020

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Douglas Fir		Lodgepole Pine		Western Hemlock		Western Red Cedar		Western White Pine		Target SPH	**Total SPH Conifers**	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020		**2018**	**2020**
36 Km Borrow Pit	0.5	1	800	1,200	0	0	0	0	0	0	0	0	1000	**800**	**1,200**
Boulder Powerhouse and Spoil/ Operators Residence	1.4	1	0	5,200	0	600	200	600	400	400	0	200	1000	**600**	**7,000**

Deciduous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood		Red Alder		**Total SPH Deciduous**	
			2018	2020	2018	2020	**2018**	**2020**
36 Km Borrow Pit	0.5	1	1,800	9,200	400	400	**2,200**	**9,600**
Boulder Powerhouse and Spoil/ Operators Residence	1.4	1	0	24,000	0	0	**0**	**24,000**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Falsebox		Kinnikinnick		Red Osier Dogwood		Red Raspberry		Sitka Mountain-Ash		Thimbleberry		Vaccinium Species		Willow		**Total SPH Shrubs**	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
36 Km Borrow Pit	0.5	1	0	400	0	0	0	0	0	0	0	200	0	0	200	0	0	0	**200**	**600**
Boulder Powerhouse and Spoil/ Operators Residence	1.4	1	0	800	0	200	200	200	400	7,200	0	0	400	2,800	0	0	0	200	**1,000**	**11,400**

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
36 Km Borrow Pit	1	1	2	2	1	2	**4**	**5**
Boulder Powerhouse and Spoil/ Operators Residence	2	5	0	1	3	6	**5**	**12**

6.1.2 Zone 2 Results Summary

Zone 2 includes two sites - Boulder Spoil #2 and the Explosive Magazine. Boulder Spoil #2 is located on a steep slope with compact soils and numerous rocky patches. This site is marginally reforestable due to compact soils. The site was planted in 2017 and had poor survival of the planted conifers and shrubs. The target of 1000 sph target for conifers has not been attained on this site. The number of conifers has increased slightly since 2017, from zero to 100 conifer sph. The number of shrubs per ha has increased and diversity has also increased with vaccinium infilling naturally. The falsebox and thimbleberry have grown in size and the grass cover has increased. Replanting this site is not recommended due to site limiting factors. It is the only area in the Civil Works sites that is not meeting the minimum conifer criteria. Conifer ingress may increase over time as the shrub and herbaceous species add more biomass to the soils and shade to the site. Adjacent to the site there are live mature Douglas-fir and Western hemlock that will provide a viable seed source. Despite steep slopes and compact soils no erosion or siltation was noted on this site. Moss cover has increased overall but there is still minimal cover on this site.

The Explosive Magazine site is one of the more natural looking sites. A good mix of mineral soil and organics has created an ideal growing medium for all the species on site. This area was planted at a lower density of 600 sph in 2018 as it was accidentally planted in 2017 by the Ministry of Forests, Lands and Natural Resource Operations and Rural Development (MFLNRORD) during their reforestation project of the Boulder Creek fire. Species diversity has not increased on this site but the number of sph has increased for all species except red alder. Douglas- fir and western redcedar have continued to infill from natural seed sources. All conifers are growing well and are free of any forest health concerns or pests. The deciduous component will add to the seral stage diversity of the stand. Shrub cover in the Explosive Magazine area is high and will remain high until the conifers emerge from the shrub cover and begin to shade them out. Moss cover has increased significantly on this site since 2018. Overall, this site exceeds the revegetation targets for the project. No erosion or siltation was noted while on site.

Figure 2. Zone 2 Plot Photos from 2018 and 2020

Card: Civil Works
Stratum: 2018 Boulder Spoil #2/Plot: K/Comments
Overview photo looks South towards plot center. Sep 26, 2018 12.53.38 PM.jpg

Card: Civil Works
Stratum: 2020 Boulder Spoil #2/Plot: K/Comments
Overview photo looks South from plot K.jpg

Card: Civil Works
Stratum: 2018 Boulder Spoil #2/Plot: L/Comments
Overview photo looks South towards plot center. Sep 26, 2018 01.10.41 PM.jpg

Card: Civil Works
Stratum: 2020 Boulder Spoil #2/Plot: L/Comments
Overview photo looks South from plot L.jpg

Card: Civil Works
Stratum: 2018 Explosive Magazine/Plot: 001/Comments Overview photo looks North towards plot center. Sep 05, 2018 11.22.20 AM.jpg

Card: Civil Works
Stratum: 2020 Explosive Magazine/Plot: 001/Comments Overview photo looks South from plot 001.jpg

Card: Civil Works
Stratum: 2018 Explosive Magazine/Plot: 002/Comments Overview photo looks North towards plot center. Sep 05, 2018 12.20.55 PM.jpg

Card: Civil Works
Stratum: 2020 Explosive Magazine/Plot: 002/Comments Overview photo looks South from plot 002.jpg

Card: Civil Works
Stratum: 2018 Explosive Magazine/Plot: 003/Comments Overview photo looks North toward plot center. Sep 05, 2018 11.47.35 AM.jpg

Card: Civil Works
Stratum: 2020 Explosive Magazine/Plot: 003/Comments Overview photo looks South from plot 003.jpg

Card: Civil Works
Stratum: 2018 Explosive Magazine/Plot: 004/Comments Sep 05, 2018 12.02.37 PM.jpg

Card: Civil Works
Stratum: 2020 Explosive Magazine/Plot: 004/Comments Overview photo looks South from plot 004.jpg

Table 2. Zone 2 – Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Douglas Fir		Lodgepole Pine		Western Red Cedar		Target SPH	**Total SPH Conifers**	
			2018	2020	2018	2020	2018	2020		**2018**	**2020**
Boulder Spoil #2	1.25	2	0	100	0	0	0	0	1000	**0**	**100**
Explosive Magazine	2.5	4	400	1,300	50	100	50	250	1000	**500**	**1,650**

Deciduous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Bigleaf Maple		Black Cottonwood		Red Alder		**Total SPH Deciduous**	
			2018	2020	2018	2020	2018	2020	**2018**	**2020**
Boulder Spoil #2	1.25	2	0	0	0	0	0	0	**0**	**0**
Explosive Magazine	2.5	4	50	150	250	500	100	100	**400**	**750**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Ceanothus		Falsebox		Red Raspberry		Rose Species		Thimbleberry		Vaccinium Species		Willow		**Total SPH Shrubs**	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
Boulder Spoil #2	1.25	2	0	0	700	900	0	0	100	200	1,400	2,000	0	300	0	0	**2,200**	**3,400**
Explosive Magazine	2.5	4	50	100	0	0	3,900	11,650	0	0	2,250	2,150	0	0	8,650	9,050	**14,850**	**22,950**

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
Boulder Spoil #2	0	1	0	0	3	4	**3**	**5**
Explosive Magazine	3	3	3	3	4	4	**10**	**10**

6.1.3 Zone 3 Results Summary

Zone 3 includes two sites - the 41.7 Km Laydown and the Upper Lillooet Penstock. The 41.7 Km Laydown has been divided into two data sets. The portion of the laydown located on the West side of the Lillooet River forest service road (FSR) was planted in 2017 with berry shrubs to meet the requirements of the grizzly bear management strategy and was subsequently planted in 2018 with a mix of conifer species. The portion of the laydown site located on the East side of the FSR was planted in 2018 and is described in Section 6.2 of this document. The terrain in this site is mainly flat and was mounded when the site was reclaimed. Soils contain a good mix of mineral and organics. The area currently exceeds the conifer density target of 1000 sph with a total of 1900 sph. The planted conifers are of good form and vigour with strong leader growth. Natural ingress of Douglas-fir continues on site with naturals ranging from 5 to 25 cm in height. Cottonwood numbers continue to increase. The cottonwoods are not out competing the conifers and are adding biomass to the site annually. The number of shrub species on site has not increased but the number of sph has increased, which indicates the site is continuing to recover. This increase in number of species is due to the conifer planting treatment in 2018. No soil erosion or siltation was noted at the time of the survey. Moss cover continues to increase and is dependent on microtopography at this time. Moss cover will continue to increase as more shading is created by the growing herbs, shrubs and trees onsite.

The Upper Lillooet Penstock is a long linear site that follows the buried penstock. This area was not planted and has no wildlife specific planting requirements. Four plots were established in 2018. The plot at the north end of the penstock was partially disturbed since plot data was collected in 2018 (Year 1). The disturbance involved approximately a quarter of the plot area being machine bladed. The disturbed area has started to recover and it was determined that the disturbance was not significant enough to drop the plot from the data set. The penstock has good distribution of coarse woody debris and soils are not compacted. Natural ingress of conifers has increased significantly between 2018 and 2020 and this site exceeds the conifer target of 1000 sph with 3150 coniferous sph. The conifers range from 10 to 35 cm in height and have patchy distribution. The penstock has also had significant infilling of deciduous species with over 8000 sph of cottonwood and red alder. The conifer and deciduous species will eventually need to be manually brushed to protect the integrity of the penstock. Brushing will not likely be required for another 5 to 8 years. Shrub diversity has increased significantly from three species to seven species. Minor ungulate browse was noted on the ceanothus and willow. No erosion or siltation issues were noted during the survey. The moss cover is increasing slowly and is dependent on microtopgraphy. No forest health issues were noted on any of the species.

Figure 3. Zone 3 Plot Photos from 2018 and 2020

Card: Civil Works
Stratum: 2018 41.7km Laydown/Plot: M/Comments Overview photo looks South towards plot center. Sep 26, 2018 02.04.09 PM.jpg

Card: Civil Works
Stratum: 2020 41.7 Km Borrow Pit/Plot: M/Comments Overview photo looks South from plot M.jpg

Card: Civil Works
Stratum: 2018 41.7km Laydown/Plot: N/Comments Overview photo looks South towards plot center. Sep 26, 2018 02.15.33 PM.jpg

Card: Civil Works
Stratum: 2020 41.7 Km Borrow Pit/Plot: N/Comments Overview photo looks South from plot N.jpg

Card: Civil Works
Substrate: 2019 Upper Lillooet Penstock/Plot O/Comments
Overview photo looks South towards plot center. Sep 25, 2019 02:49:29 PM.jpg

Card: Civil Works
Substrate: 2020 Upper Lillooet Penstock/Plot O/Comments
Overview photo looks South from plot O.jpg

Card: Civil Works
Substrate: 2018 Upper Lillooet Penstock/Plot P/Comments
Overview photo looks South towards plot center. Sep 26, 2018 02:53:52 PM.jpg

Card: Civil Works
Substrate: 2020 Upper Lillooet Penstock/Plot P/Comments
Overview photo looks South from plot P.jpg

Card: Civil Works
Stratum: 2018 Upper Lillooet Penstock/Plot: I/Comments
Overview photo looks South towards plot center. Sep 18, 2018 02.11.15 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Lillooet Penstock/Plot: I/Comments
Overview photo looks South from plot I.jpg

Card: Civil Works
Stratum: 2018 Upper Lillooet Penstock/Plot: H/Comments
Overview photo looks South towards plot center. Sep 18, 2018 01.15.06 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Lillooet Penstock/Plot: H/Comments
Overview photo looks South from plot H.jpg

Card: Civil Works
Survey: 2020 Upper Lillooet Penstock/Adit
F/Comments
Site has been partially disturbed since 2019.jpg

Table 3. Zone 3 - Vegetation Density and Species Diversity from 2018 to 2020

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Douglas Fir		Spruce		Western Red Cedar		Western White Pine		Target SPH	**Total SPH Conifers**	
			2018	2020	2018	2020	2018	2020	2018	2020		**2018**	**2020**
41.7 Km Laydown	1.1	2	0	1,300	0	600	0	0	0	0	1000	**0**	**1,900**
Upper Lillooet Penstock	4.6	4	250	2,900	0	0	0	200	0	50	1000	**250**	**3,150**

Deciduous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood		Red Alder		**Total SPH Deciduous**	
			2018	2020	2018	2020	**2018**	**2020**
41.7 Km Laydown	1.1	2	800	3,400	0	0	**800**	**3,400**
Upper Lillooet Penstock	4.6	4	450	7,800	0	450	**450**	**8,250**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Ceanothus		Douglas Maple		Falsebox		Oregon Grape		Red Osier Dogwood		Red Raspberry		Thimbleberry		Willow		**Total SPH Shrubs**	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
41.7 Km Borrow Pit	1.1	2	0	0	0	0	0	0	300	200	0	0	600	3,800	500	1,400	0	0	**1,400**	**5,400**
Upper Lillooet Penstock	4.6	4	0	50	0	50	0	50	0	0	50	50	900	7,850	250	650	550	150	**1,750**	**8,850**

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
41.7 Km Borrow Pit	0	2	1	1	3	3	**4**	**6**
Upper Lillooet Penstock	1	3	1	2	4	7	6	12

6.1.4 Zone 4 Results Summary

Zone 4 is composed of one site - Upper Spoil #6. This site has gentle slopes and was mounded when the site was reclaimed. The soils are gravelly but have moderate amounts of organics mixed in and are not too compacted. The site was planted in the fall of 2018 with a mix of coniferous species. Douglas-fir naturals were already infilling prior to planting. This site exceeds the target of 1000 sph with 4000 sph of conifers. The planted and natural conifers are well established on site and have excellent leader growth. The density of black cottonwoods has increased significantly from 400 sph to 7400 sph. Many of these stems are still quite short (< 5 cm) but will grow quickly to occupy the site. The shrub layer, although not very diverse, is greening up nicely. Shrub diversity is not expected to increase much as the fast growing alder and willow will shade out other shrub species trying to establish onsite. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal.

Figure 4. Zone 4 Plot Photos from 2018 and 2020

Card: Civil Works
Stratum: 2018 Upper Spoil #6/Plot: 1/Comments
Overview photo looks South towards plot center. Sep 18, 2018 02.23.18 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #6/Plot: 1/Comments
Overview photo looks South from plot 1.jpg

Table 4. Zone 4 - Vegetation Density and Species Diversity from 2018 to 2020

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Douglas Fir		Spruce		Western Red Cedar		Target SPH	Total SPH Conifers	
			2018	2020	2018	2020	2018	2020		**2018**	**2020**
Upper Spoil #6	1	1	1,200	2,800	0	400	0	800	1000	**1,200**	**4,000**

Deciduous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood		Total SPH Deciduous	
			2018	2020	**2018**	**2020**
Upper Spoil #6	1	1	400	7,400	**400**	**7,400**

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Sitka Alder		Willow		Total SPH Shrubs	
			2018	2020	2018	2020	**2018**	**2020**
Upper Spoil #6	1	1	200	200	0	200	**200**	**400**

Number of Species From Plot Data (SPH)

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		Total Number of Species	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
Upper Spoil #6	1	3	1	1	1	2	**3**	**6**

6.1.5 Zone 5 Results Summary

Zone 5 is composed of three sites - Upper Spoil #3, Upper Spoil #4 and Upper Spoil #8. All three of these spoil sites were planted in 2017 with berry shrubs to meet the requirements of the grizzly bear management strategy and were subsequently planted in 2018 with a mix of conifer species. Upper Spoil #3 has mostly flat terrain with steeper slopes on the south side of the polygon. The steeper area was contoured to keep the spoil site from raveling onto the mainline. The flatter portion of the site was mounded prior to planting. Soils are mostly coarse and although they are quite compact the planted and natural vegetation has been successful in establishing on site. This site exceeds the target of 1000 sph with 1800 sph of conifers. In general, the conifers are of good form and vigour with some stems exhibiting minor drought stress in the form of chlorotic or dead needles on the lower half of the tree. The drought damage is minimal and the affected trees are expected to make a full recovery. Cottonwoods continue to infill on site and will add biomass to the coarse soils over time. The shrub complex has not increased in diversity or stem density but the plants are getting larger and are well established. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal.

Spoil #4 has moderate to gentle slopes and was mounded prior to planting. Soils are mostly gravelly with some organics and sand mixed in. This site had good survival of the planted trees with Douglas-fir and amablis fir continuing to infill. The planted and natural conifers are of good form and vigour with moderate to strong leader growth. This site exceeds the target of 1000 sph with 1900 sph of conifers. There are fewer cottonwoods on this site but their numbers continue to increase. The planted and natural shrubs are also growing well and although species diversity has not increased the number of sph has increased from 1200 sph to 4100 sph. The increase in the number of sph ensures biomass will be added to the soils annually, thus increasing the organic component of the soils over time. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal.

Spoil #8 has concave terrain and is partially mounded. Soils are relatively sandy with a minor component of pumice, making them well drained. The area of Spoil #8 was increased after the berry shrubs were planted and the permanent plots were established. The additional area was not planted with berry shrubs but was planted with conifers. The conifer planting treatment was successful and planted and natural conifers are growing well onsite with nice foliage and good leader growth. Douglas-fir, amabilis fir and Western hemlock continue to infill across the site. This site exceeds the target of 1000 sph with 6800 sph. Many of the conifers are still germinants and their survival is not guaranteed. Cottonwood numbers have exploded onsite – increasing from 200 sph to 4000 sph. The majority of the cottonwoods are significantly shorter than the planted conifers and are not expected to out compete the conifers. The shrub complex on site is diverse with a ceanothus and Sitka alder infilling naturally. The planted shrubs continue to grow in size and are well established. In 2018 there was some erosion and settling on the site. This was likely due to the sandy nature of the site. No new erosion or settling was noted in 2020. Moss cover is increasing slowly but cover is still quite minimal and dependent on microtopography.

Figure 5. Zone 5 Plot Photos from 2018 and 2020

Card: Civil Works
Stratum: 2018 Upper Spoil #3/Plot: D/Comments
Overview photo looks South towards plot center. Sep 18, 2018 10.54.28 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #3/Plot: D/Comments
Overview photo looks South from plot D.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #3/Plot: E/Comments
Overview photo looks South towards plot center. Sep 18, 2018 11.08.44 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #3/Plot: E/Comments
Overview photo looks South from plot E.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #4/Plot: F/Comments
Overview photo looks South towards plot center. Sep 18, 2018 12.00.57 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #4/Plot: F/Comments
Overview photo looks South from plot F.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #4/Plot: G/Comments
Overview photo looks South towards plot center. Sep 18, 2018 12.20.59 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #4/Plot: G/Comments
Overview photo looks South from plot G.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #8/Plot: 005/Comments Overview photo looks North towards plot center. Sep 05, 2018 02.03.09 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #8/Plot: 005/Comments Overview photo looks South from plot 005.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #8/Plot: 006/Comments Overview photo looks North towards plot center. Sep 05, 2018 02.13.28 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #8/Plot: 006/Comments Overview photo looks South from plot 006.jpg

Table 5. Zone 5 - Vegetation Density and Species Diversity from 2018 to 2020

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Amabalis Fir		Douglas Fir		Mountain Hemlock		Spruce		Western Hemlock		Western Red Cedar		Western White Pine		Target SPH	Total SPH Conifers	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020		2018	2020
Upper Spoil #3	1.1	2	0	300	0	1,300	0	0	0	200	0	0	0	0	0	0	1000	0	1,800
Upper Spoil #4	1.6	2	0	100	0	1,100	0	0	0	700	0	0	0	0	0	0	1000	0	1,900
Upper Spoil #8	2.2	2	0	1,100	100	4,600	0	200	0	100	0	400	0	300	0	100	1000	100	6,800

Deciduous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood		Total SPH Deciduous	
			2018	2020	2018	2020
Upper Spoil #3	1.1	2	1,300	2,900	1,300	2,900
Upper Spoil #4	1.6	2	300	500	300	500
Upper Spoil #8	2.2	2	200	4,000	200	4,000

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Falsebox		Ceanothus		Red Osier Dogwood		Red Raspberry		Sitka Alder		Thimbleberry		Willow		Total SPH Shrubs	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
Upper Spoil #3	1.1	2	0	0	0	0	0	0	1,300	1,300	0	0	300	300	100	100	1,700	1,700
Upper Spoil #4	1.6	2	0	0	0	0	100	100	800	3,200	0	0	300	800	0	0	1,200	4,100
Upper Spoil #8	2.2	2	400	500	0	100	100	100	1,600	12,700	0	100	0	0	200	500	1,900	13,300

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		Total Number of Species	
	2018	2020	2018	2020	2018	2020	2018	2020
Upper Spoil #3	0	3	1	1	3	3	4	7
Upper Spoil #4	0	3	1	1	3	3	4	7
Upper Spoil #8	1	7	1	1	4	6	6	14

6.1.6 Zone 6 Results Summary

Zone 6 is the largest area surveyed and consists of five sites - the Diversion Channel and Slopes, Keyhole Laydown, Upper Intake and Laydown, Upper Spoil #1 and Upper Spoil #2 and Settling Basin. All the sites in Zone 6 except the Keyhole Laydown site were planted with berry shrubs in 2017. The Diversion Channel and Slopes appear to have been grass seeded with a fall rye seed mix. This site has moderate slopes and was roughed up with a machine prior to berry planting, grass seeding and conifer planting. In 2018 a mix of high elevation conifers were planted. Despite having coarse soils and a shorter growing season this site has had good conifer survival. Amabilis fir and Western hemlock were already infilling in 2018 and continue to seed in. Some of the naturals are still in the germinant stage and were a bit chlorotic. The planted conifers have moderate to strong leader growth. Some drought stress was noted but generally the trees look good. This site exceeds the target of 1000 sph with 2666 sph. Cottonwood numbers have increased significantly from 133 sph in 2018 to 1933 sph in 2020. A minor amount of red alder has also infilled. The cottonwood and red alder will add biomass to the site, increasing organic matter in the coarse soils. Red alder will also increase nitrogen levels in the soil, improving growing conditions for other species. The shrub complex on this site is growing well and has increased in diversity and number of sph since 2018. Red Elderberry numbers have decreased slightly since 2018. This is likely due to the dieback of one or two plants in the plots. Overall, this site is well on its way to meeting revegetation targets.

Keyhole Laydown is a small site that had minimal soil disturbance and looks very natural. This site was planted in 2018 with conifers. The planted and natural amabilis fir are of fair to good form and vigour with moderate leader growth. They are growing a bit slower than some of the adjacent sites, likely due to increased competition from the well-developed shrub complex on site. This site exceeds the target of 1000 sph with 1400 sph. The shrub community has not increased in diversity but there are more sph of most species and all species have grown taller since 2018. Highbrush cranberry and vaccinium stem numbers decreased since 2018.This could be due to an error in stem counts as it was difficult to accurately count the plants due to high site occupancy. Overall, this site continues to meet the revegetation targets of a recovering site. No erosion or siltation was noted during the survey. Moss cover has started to fill in where there is exposed mineral soil.

The Upper Intake and Laydown is a large site that was mounded prior to reforestation activities. The portion of the site located above the Lillooet River FSR was contoured and grass seeded to increase slope stability and decrease raveling down to the FSR. Soils are variable on this site, the area above the FSR are slightly compact despite the site prep that was completed. Below the FSR there is an increased component of sand in the soil making them less compact and well drained. In 2017 the site was planted with a mix of berry shrubs and larger conifers grown in five-gallon pots, in 2018 conifers were planted to increase stem density to meet the stocking target of 1000 sph. Conifer diversity is good on this site with six different species, some planted and some occurring naturally. Density of the conifers has increased from 600 sph to 3100 sph. Below the FSR many of the conifers have chlorotic needles and moderate leader growth. Despite the rapidly draining site conditions very little mortality was noted. Above the FSR chlorosis of the needles is less noticeable, and the planted and natural conifers are exhibiting moderate to strong leader growth. The conifers range from 3 cm germinants to 85 cm planted conifers. The average height is 35 cm. Deciduous stem counts have increased significantly from 533 sph in 2018 to 5601 sph in 2020. Black Cottonwood makes almost all of the deciduous component. Many of the cottonwoods are still quite small but are expected to start to grow faster as they become more established onsite. The shrub complex has decreased in diversity since 2018 with the loss of kinnikinnick and thimbleberry. Both of these species were planted and may have succumbed to drought stress. The shrub count has increased from 800 sph to 1290 sph. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal and dependent on microtopography.

Upper Spoil #1 is the highest elevation site in the civil works areas. This site was mostly mounded the sides of the spoil were contoured for stability and are rockier. Soils are coarse with some boulders mixed in. There is scattered coarse woody debris. The spur road into the site was rehabbed and mounded in 2018 but has since been reactivated since then, one of the plots was partially disturbed by the reactivation. This plot was not removed from the data set as less than 50% of the plot was disturbed and there were signs that the herbs and shrubs were starting to grow back. Berry shrubs were planted in 2017 and a mix of high elevation conifers were planted in 2018. The tree planting treatment was successful and the site is stocked with 1866 sph exceeding the reforestation target of 1000 sph. Some natural ingress of conifers was noted, the naturals range from 3 to 10 cm in height. The planted conifers have an average height of 30 cm. The conifers are growing well onsite and are free from any forest health issues. The number of deciduous trees has increased significantly from 533 sph in 2018 to 5601 sph in 2020. The deciduous sph will increase steadily increase the organic component of the soils with annual leaf fall. The shrub complex emerging has increased in diversity and sph. In 2018 there were 934 sph of shrubs in 2020 this had increased to 6400. Salal numbers have decreased slightly since 2018. This is likely due to the dieback of one or two plants in the plots. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal and dependent on microtopography.

The Upper Spoil #2 and Settling Basin site had a large amount of overburden placed on the site creating a large mound with a flat top. The coarse gravel soils were fluffed up by mounding and there is some scattered coarse woody debris. The Southeast portion of the site has more sand mixed into the soil and is a bit less compact than the rest of the site. There is a small area (0.06 ha) area that had a couple of dump truck loads of soil dropped onto the site. This newly disturbed area is not stocked. To replant this area approximately 100 trees would need to be planted. Spoil #2 was planted with berry shrubs in 2017 and was planted with a mix of conifers in 2018. The conifers had good survival rates and is currently stocked with 1550 sph exceeding the target stocking levels of 1000 sph. The conifers are of good form and vigour with moderate to strong leader growth. The deciduous component has increased significantly from 50 sph to 5300 sph, the majority of the deciduous sph are cottonwood. The planted shrubs are growing well onsite with moderate increases in the number of sph. In 2018 there were 500 sph, in 2020 that number had increased to 700 sph. No erosion or siltation was noted during the survey. Moss cover is increasing slowly but cover is still quite minimal and dependent on microtopography.

Figure 6. Zone 6 Plot Photos from 2018 and 2020

Card: Civil Works
Stratum: 2018 Diversion Channel Slopes/Plot: 008/Comments
Overview photo looks towards plot center from the North side of the plot. Sep 06, 2018 02.54.31 PM.jpg

Card: Civil Works
Stratum: 2020 Diversion Channel and Slopes/Plot: 008/Comments
Overview photo looks South from plot 0p8.jpg

Card: Civil Works
Stratum: 2018 Diversion Channel Slopes/Plot: 009/Comments
Overview photo looks at plot from the North side. Sep 06, 2018 03.00.40 PM.jpg

Card: Civil Works
Stratum: 2020 Diversion Channel and Slopes/Plot: 009/Comments
Overview photo looking South from plot 009.jpg

Card: Civil Works
Stratum: 2018 Diversion Channel Slopes/Plot: 013/Comments
Overview photo looks South towards plot center. Sep 07, 2018 12.01.34 PM.jpg

Card: Civil Works
Stratum: 2020 Diversion Channel and Slopes/Plot: 013/Comments
Overview looking South plot 013.jpg

Card: Civil Works
Stratum: 2018 Keyhole Laydown/Plot: 00/Comments
Overview photo looks towards plot center from North side of plot. Sep 06, 2018 02.13.30 PM.jpg

Card: Civil Works
Stratum: 2020 Keyhole Laydown/Plot: 007/Comments
Looking South plot center 007.jpg

Card: Civil Works
Structure: 2018 Lower Intake and Laydown/Plot: B/Comments:
Overview photo looks South towards plot center. Sep 19, 2018 09 12 42 AM.jpg

Card: Civil Works
Structure: 2020 Upper Intake and Laydown/Plot: B/Comments:
Overview photo looks South from plot B.jpg

Card: Civil Works
Structure: 2018 Lower Intake and Laydown/Plot: C/Comments:
Overview photo looks South towards plot center. Sep 19, 2018 09 21 05 AM.jpg

Card: Civil Works
Structure: 2020 Upper Intake and Laydown/Plot: C/Comments:
Overview photo looks South from plot C.jpg

Card: Civil Works
Station : 2019 Upper Intake and Laydown/Plot 014/Comments
Overview photo looks South towards plot center. - Sep 07, 2019 02:40:28 PM.jpg

Card: Civil Works
Station : 2020 Upper Intake and Laydown/Plot 014/Comments
Overview photo looks South from plot 014.jpg

Card: Civil Works
Station : 2019 Upper Intake and Laydown/Plot A/Comments
Overview photo looks South towards plot center. - Sep 18, 2019 09:33:54 AM.jpg

Card: Civil Works
Station : 2020 Upper Intake and Laydown/Plot A/Comments
Overview looking South from plot a.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #1/Plot: 010/Comments
Overview photo looks South towards plot center. Sep 07, 2018 09.44.26 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #1/Plot: 010/Comments
OV looking South.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #1/Plot: 011/Comments
Overview photo looks South towards plot center. Sep 07, 2018 09.55.49 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #1/Plot: 011/Comments
Overview photo looks South from plot 011.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil Y1/Plot: 012/Comments
Overview photo looks South towards plot center. Sep 07, 2018 10.17.17 AM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil Y1/Plot: 012/Comments
Overview photo looks South from plot 012.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 017/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.27.45 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 017/Comments
Overview photo looks South from plot 017.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 018/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.37.08 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 018/Comments
Overview photo looks South from plot 018.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 015/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.03.11 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 015/Comments
Overview photo looks South from plot 015.jpg

Card: Civil Works
Stratum: 2018 Upper Spoil #2 & Settling Basin/Plot: 016/Comments
Overview photo looks South towards plot center. Sep 07, 2018 03.18.21 PM.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #2 and Settling Basin/Plot: 016/Comments
Overview photo looks South from plot 016.jpg

Table 6. Zone 6- Vegetation Density and Species Diversity from 2018 to 2020

Coniferous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Amabalis Fir		Douglas Fir		Lodgepole Pine		Mountain Hemlock		Spruce		Western Hemlock		Western Red Cedar		Target SPH	Total SPH Conifers	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020		2018	2020
Diversion Channel and Slopes	2.5	3	267	2,133	0	133	0	0	0	67	0	333	0	0	0	0	1000	267	2,666
Keyhole Laydown	0.1	1	200	1,400	0	0	0	0	0	0	0	0	0	0	0	0	1000	200	1,400
Upper Intake and Laydown	2.4	4	300	2,100	100	300	0	50	0	0	0	350	50	50	150	250	1000	600	3,100
Upper Spoil #1	2.4	3	0	533	0	200	0	0	0	0	0	1,000	0	0	0	133	1000	0	1,866
Upper Spoil #2 and Settling Basin	2.8	4	0	650	0	600	0	0	0	0	0	300	0	0	0	0	1000	0	1,550

Deciduous Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Black Cottonwood		Red Alder		Trembling Aspen		Total SPH Deciduous	
			2018	2020	2018	2020	2018	2020	2018	2020
Diversion Channel and Slopes	2.5	3	133	1,933	0	400	0	0	133	2,333
Keyhole Laydown	0.1	1	0	0	0	0	0	0	0	0
Upper Intake and Laydown	2.4	4	1,700	16,400	0	200	0	0	1,700	16,600
Upper Spoil #1	2.4	3	533	5,467	0	67	0	67	533	5,601
Upper Spoil #2 and Settling Basin	2.8	4	50	5,050	0	250	0	0	50	5,300

Shrub Diversity From Plot Data (SPH)

Site	Area (Ha)	# Plots	Hardhack Spirea		Highbrush Cranberry		Kinnikinnick		Oregon Grape		Red Elderberry		Red Osier Dogwood		Red Raspberry		Rose Species	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
Diversion Channel and Slopes	2.5	3	0	0	67	67	0	0	0	0	133	67	0	67	0	133	0	0
Keyhole Laydown	0.1	1	0	0	800	600	0	0	0	0	600	800	0	0	14,800	46,400	0	0
Upper Intake and Laydown	2.4	4	0	0	0	0	50	0	50	50	30	40	0	0	0	0	100	100
Upper Spoil #1	2.4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upper Spoil #2 and Settling Basin	2.8	4	50	0	0	0	0	0	0	0	0	0	0	0	250	350	0	0

Shrub Diversity From Plot Data Continued (SPH)

Site	Area (Ha)	# Plots	Salal		Salmonberry		Sitka Alder		Sitka Mountain-Ash		Thimbleberry		Vaccinium Species		Willow		Total SPH Shrubs	
			2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
Diversion Channel and Slopes	2.5	3	133	133	67	133	267	1,000	0	133	67	67	200	267	0	933	**934**	**3,000**
Keyhole Laydown	0.1	1	0	0	0	0	0	0	0	0	0	0	7,200	4,800	400	400	**23,800**	**53,000**
Upper Intake and Laydown	2.4	4	0	0	0	0	200	50	0	0	50	0	0	0	300	1,050	**800**	**1,290**
Upper Spoil #1	2.4	3	67	0	0	0	800	2,667	0	0	67	133	0	0	0	3,600	**934**	**6,400**
Upper Spoil #2 and Settling Basin	2.8	4	50	50	0	0	100	0	0	0	50	50	0	0	0	250	**500**	**700**

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
Diversion Channel and Slopes	1	4	1	2	7	11	**9**	**17**
Keyhole Laydown	1	1	0	0	5	5	**6**	**6**
Upper Intake and Laydown	4	6	1	2	7	5	**12**	**13**
Upper Spoil #1	0	4	1	3	3	3	**4**	**10**
Upper Spoil #2 and Settling Basin	0	3	1	2	5	4	**6**	**9**

6.2. Results for Civil Work Sites Plots Established in 2019 and 2020

Within the civil works areas, 26 permanent plots were established on 8 sites in 2019 and 2020. For these sites there is only one year of monitoring data available. These sites include the 38 Km Laydown, 41.7 Km Laydown, Camp, Boulder Spoil #4, Boulder Spoil #7, Upper Spoil #5 and Upper Spoil #7. The 41.7 Km Laydown site had one new plot established on the east side of the Lillooet River FSR. The second site that had an additional plot established was the Boulder Powerhouse and Spoil. These civil works sites are not within riparian areas, Ungulate Winter Ranges or Wildlife Habitat Areas and were not planted until the fall of 2018. All sites were planted with a mix of site appropriate conifers. Shrubs and deciduous species have infilled naturally since the sites were reclaimed. A target of 1000 stems per hectare (sph) of conifers has been set for successful reforestation of the sites.

All seedlings were planted with fertilizer teabags to increase available nutrients to seedlings during their first year of growth. Fertilizer teabags are commonly used on nutrient poor sites in conventional forestry. Three types of fertilizer were used on the civil works sites. The first is a 20-gram Chilcotin Worm Blend teabag with a 15-4-4 nitrogen/phosphate/potash mix. The second is a 10-gram Chilcotin PHP teabag with a 17-5-7 mix. The third is recommended for the most difficult sites to reforest. It is a 20-gram Biochar teabag with a mix of 15-5-5. All sites except for the 38 km laydown used only one type of fertilizer. The 38 km laydown site is the largest site in the civil works project area at 13ha. The site was divided into three sections with a specific fertilizer used in each area. In 2019, five permanent plots were established in each area. The species and number of conifers in each plot was collected in 2019 and 2020. The data collected over the two years does not differentiate between planted and natural conifers so it is difficult to get completely accurate data on the efficacy of the three fertilizer types. For the 2020 vegetation monitoring assessment, 2019 plots were used as a baseline. The 2020 data was compared to that from 2019. If there were more conifers of a certain species in the 2020 plot it was assumed that these were naturals and were not added to the count to find the survival rate. For example, if there were 4 Douglas-fir in the 2019 plot and 6 Douglas fir in the 2020 plot it was assumed that the plot had 100% survival. This was done for each plot and an average percent survival was determined. Using this method, the areas where the 20-gram Biochar was used, the type recommended for the most difficult sites, had the best survival at 75%. The areas where the 20-gram Chilcotin Worm Blend and the 10-gram Chilcotin PHP fertilizer were applied had nearly the same survival rates at 65% and 66%.

All sites except Boulder Spoil #7 have met or exceeded the target of 1000 sph of conifers. This site was expected to be one of the most difficult to reforest as it has rocky compact soils that are rapidly draining. Some areas are mostly rock with minimal soil and are marginally suitable for growing conifers. The banks of the Boulder Spoil #7 site are contoured to reduce raveling into the adjacent cutblock. The site was planted with 1800 conifers per ha, and all seedlings were planted with Chilcotin fertilizer tea bags to provide extra nutrients in the first year of growth. Although less than 50% of the planted conifers survived, the site is stocked at just below target levels with 800 coniferous stems per ha. Considering the difficult growing conditions and the continuing natural ingress of cottonwoods on the site no further planting treatments are recommended.

The total conifer densities for the sites established in 2020 range from 800 stems per ha on a rocky, well drained site to 7000 stems per ha on a richer site with a viable seed source adjacent to the site. The average number of conifers stems per ha is 2300. The conifers range from 5 cm germinants to 60 cm tall planted conifers. The average height of the conifers is 34 cm. The conifers are free from forest health issues and appear to be growing well. The germinants were counted but until they have grown for a couple of years and have reached a height of 15 cm survival is variable due to their small root systems, minimal foliage and limited capabilities to deal with soil moisture deficits in the summer months.

For the sites established in 2019 and 2020 he total deciduous species densities range from 1600 to 28,800 stems per ha. The deciduous trees are important pioneer species that add biomass to the sites and in the case of alders are nitrogen fixing species that enrich the site and increase nutrient uptake by other species. Due to natural ingress, distribution and densities are variable. The average number of deciduous stems per ha is 10,414. The deciduous stems range from 5 cm to 80 cm in height.

The total shrub species densities range from 0 to 23,800 sph. Where shrub densities are high the shrub species have multiple stems originating from one root crown it was difficult to accurately count the number of plants growing in the plot. An effort was made to accurately count the number of plants in the plot as outlined in Section 5.1. The average number of shrubs per site was 8367 stems per ha. Depending on the species the shrubs ranged from 15 to 70 cm in height. All the shrubs are of good form and vigour and appear to be growing well.

The total percentage ground cover of all layers combined (herb, shrub and tree) in the quadrat surveys ranged between 3% and 13% cover. Due to the sites being dependent on natural ingress of herbaceous and shrub layers, percent cover is lower than on the sites that were grass seeded or planted with shrubs and conifers. These civil work sites were nearly devoid of any vegetation in 2018 and are showing positive signs of recovery with an average percent cover of 6%. The vegetation measured has an average height of 34 cm.

Figure 7. 38 Km Laydown Plot Photos from 2020

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W1/Comments
Overview photo looks South from plot W1.jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W2/Comments
Overview photo looks South from plot W2.jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W3/Plot Name
Overview photo looks South from plot W3.jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W3/Comments
Overview photo looks South from plot W3.jpg

Card: Civil Works
Stratum: 2020 30 km Laydown/Plot: W4/Comments
Overview photo looks South from plot W4.jpg

Card: Civil Works
Stratum: 2020 30 km Laydown/Plot: W5/Comments
Overview photo looks South from W5.jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W6/Comments
Overview photo looks South from plot W6.jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W7/Comments
Overview photo looks South from plot W7.jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W8/Comments
Overview photo looks South from plot W8.jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W9/Comments
Overview photo looks South from plot W9.jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W10/Comments
Overview photo looks South from plot W10.jpg

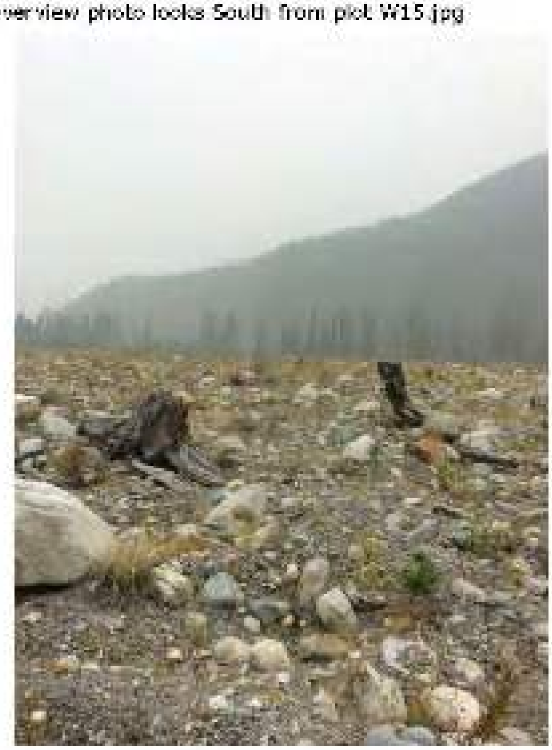
Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W11/Comments
Overview photo looks South from plot W11.jpg

Card: Civil Works
Stratum: 2020 30 km Laydown/Plot: W12/Comments
Overview photo looks South from plot W12.jpg

Card: Civil Works
Stratum: 2020 30 km Laydown/Plot: W13/Comments
Overview photo looks South from plot W13.jpg

Card: Civil Works
Stratum: 2020 30 km Laydown/Plot: W14/Comments
Overview photo looks South from W14.jpg

Card: Civil Works
Stratum: 2020 30 km Laydown/Plot: W15/Comments
Overview photo looks South from plot W15.jpg



Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W1/Species Tally: Amabalis Fir/Tree Species
Ba 20 cm tall .jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W3/Species Tally: Western Red Cedar/Tree Species
Cw 52 cm tall .jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W1/Species Tally: Douglas Fir/Tree Species
Fdc 56 cm tall .jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W1/Species Tally: Lodgepole Pine/Tree Species
Plc 61 cm tall .jpg

Card: Civil Works
Stratum: 2020 38 km Laydown/Plot: W3/Species Tally: Spruce/Tree Species
Sx 42 cm tall.jpg

Figure 8. 41.7 Km Laydown Plot Photo from 2020

Card: Civil Works
Stratum: 2020 41.7 Km Borrow Pit/Plot: U/Comments
Overview photo looks South from plot U.jpg

Figure 9. Boulder Spoil #4 and #7 Plot Photos from 2020

Card: Civil Works
Stratum: 2020 Boulder Spoil #4/Plot: D1/Comments
Overview photo looks South from plot D1.jpg

Card: Civil Works
Stratum: 2020 Boulder Spoil #7/Plot: E1/Comments
Overview photo looks South from plot E1.jpg

Card: Civil Works
Stratum: 2020 Boulder Spoil #4/Plot: D1/Species Tally:
Douglas Fir/Tree Species
Fdc 64 cm tall .jpg

Card: Civil Works
Stratum: 2020 Boulder Spoil #4/Plot: D1/Species Tally:
Spruce/Tree Species
Sx 59 cm tall .jpg

Figure 10. Camp Photos from 2020

Card: Civil Works
Stratum: 2020 Camp/Plot: B1/Comments
Overview photo looks South from plot B1.jpg

Card: Civil Works
Stratum: 2020 Camp/Plot: V/Comments
Overview photo looks South from plot V.jpg

Card: Civil Works
Stratum: 2020 Camp/Plot: W/Comments
Overview photo looks South from plot W.jpg

Card: Civil Works
Stratum: 2020 Camp/Plot: X/Comments
Overview photo looks South from plot X.jpg

Card: Civil Works
Stratum: 2020 Camp/Plot: Y/Plot Name
Overview photo looks South from plot Y.jpg

Card: Civil Works
Stratum: 2020 Camp/Plot: Z/Comments
Overview photo looks South from plot Z.jpg

Card: Civil Works
Stratum: 2020 Camp/Plot: V/Species Tally: Lodgepole Pine/Tree Species
60 cm Plc.jpg

Card: Civil Works
Stratum: 2020 Camp/Plot: W/Species Tally: Douglas Fir/Tree Species
Fdc 50 cm tall .jpg

Figure 11. Upper Spoil #5 Plot Photos from 2020

Card: Civil Works
Stratum: 2020 Upper Spoil #5/Plot: F1/Comments
Overview photo looks South from plot F1.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #5/Plot: F1/Species Tally:
Amabalis Fir/Tree Species
Ba 29 cm tall .jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #5/Plot: F1/Species Tally:
Douglas Fir/Tree Species
Fdc 15 cm tall.jpg

Card: Civil Works
Stratum: 2020 Upper Spoil #5/Plot: F1/Comments
Hw naturals infilling.jpg

Figure 12. Upper Spoil #7 Plot Photos from 2020

Card: Civil Works
Stratum: 2020 Upper Spoil #7/Plot: T/Comments
Overview photo looks South from plot T.jpg

6.3. Results for Transmission Line Sites

The transmission line plot data collected in Year 3 (2020) has been summarized by site comparing the plant communities present in 2018 (Year 1) and 2020 (Year 3). No new plots were established in 2020 within the transmission line portion of the ULHP revegetation project.

The transmission line road sites continue to successfully regenerate. All sites show an increase in species diversity and density. Some sites did have decreases in the number of sph for one or two species but always had an increase in diversity. The decrease in sph is not a sign of the site being unable to regenerate but is an example of site succession on a small scale. In general, all species of plants were of good form and vigour and free from any forest health pests. The only plants that were looking spindly or weak were being shaded out by more aggressive species. Each surveyed road site is summarized below.

6.3. Transmission Line Road Site 53.1/56.1 Summary

Transmission line road 53.1/56.1 is deactivated and is not drivable. Soils are rapidly draining and coarse with lots of surface rock. This site was grass seeded with a fall rye blend. No conifers were recorded at this site. Black cottonwood numbers have increased since 2018 to 3000 sph. Thimbleberry and red raspberry numbers have also increased significantly over the last two years. The thimbleberry is not growing as vigorously on this site but that may be due to the rapidly draining soils. Species diversity has increased with red osier dogwood and willow now growing onsite. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 13. 53.1/56.1 Plot Photos from 2018 and 2020

Table 7. 53.1/56.1 - Vegetation Density and Species Diversity from 2018 to 2020

Coniferous Diversity From Plot Data (SPH)

Site	Total SPH Conifers	
	2018	**2020**
53.1/56.1	**0**	**0**

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		Total SPH Deciduous	
	2018	2020	**2018**	**2020**
53.1/56.1	1800	3000	**1800**	**3000**

Shrub Diversity From Plot Data (SPH)

Site	Red Osier Dogwood		Red Raspberry		Thimbleberry		Willow		Total SPH Shrubs	
	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
53.1/56.1		200	400	800	800	2200		200	**1200**	**3400**

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		Total Number of Species	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
53.1/56.1	0	0	1	1	2	4	**3**	**5**

6.3.1 Transmission Line Road 73.1 Summary

Transmission line road 73.1 is deactivated and is not drivable. The soils are coarse but not too rocky. Coarse woody debris was added to the road after it was decompacted. This site is dominated by thimbleberry and red raspberry. The number of sph of thimbleberry have decreased slightly from 17800 in 2018 to 16000 in 2020 but the height and width of the plants has increased significantly. Douglas fir naturals have also filled in at 400 sph. Most of Douglas fir are still quite small ranging from 5 to 18 cm in height. They have seeded in where there is available mineral soil and they are not overtopped by shrubs. Black cottonwood has also seeded in at 5800 sph. Despite the site being dominated by thimbleberry and red raspberry falsebox and willow have seeded in and are growing well on the site. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 14. 73.1 Plot Photos from 2018 and 2020

Card: Transmission Line
Stratum: 2018 73.1/Plot: 30/Comments
Sep 18, 2018 12.50.06 PM.jpg

Card: Transmission Line
Stratum: 2020 73.1/Plot: 30/Comments
Overview photo looks South from plot 73.1.jpg

Table 8. 73.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		**Total SPH Conifers**	
	2018	2020	**2018**	**2020**
73.1	0	400	**0**	**400**

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		**Total SPH Deciduous**	
	2018	2020	**2018**	**2020**
73.1	0	5,800	**0**	**5,800**

Shrub Diversity From Plot Data (SPH)

Site	Falsebox		Red Raspberry		Thimbleberry		Willow		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
73.1	0	1,200	1,600	10,000	17,800	16,800	0	400	**19,400**	**28,400**

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
73.1	0	1	0	1	2	4	**2**	**6**

6.3.2 Transmission Line Road 129.1 Summary

Transmission line road 129.1 is deactivated and is not drivable. Soils are rapidly draining and coarse with lots of surface rock. This site was grass seeded with a fall rye blend. Lodgepole pine continues to seed in naturally and is growing well on this dry site. Lodgepole pine numbers have increased from 1200 sph in 2018 to 1600 sph in 2020. The lodgepole pine range from 30 cm to 55 cm in height. A few black cottonwoods have filled in naturally at 400 sph. This site has decreased in the number of shrubs since 2018. This is likely due to high temperatures in the summer and a lack of soil moisture. Falsebox numbers have decreased by half from 2018 to 2020, there are currently 1000 sph of falsebox onsite. Ceanothus numbers have also decreased from 400 sph in 2018 to 200 sph in 2020. Both of these species are typically drought tolerant, but may be more susceptible to drought conditions when they are smaller and their root system is not developed enough to survive season long drought conditions. The grass seeding treatment could also have created more competition between plants for water. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 15. 29.1 Plot Photos from 2018 and 2020

Table 9. 129.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Lodgepole Pine		**Total SPH Conifers**	
	2018	2020	**2018**	**2020**
129.1	1,200	1,600	**1,200**	**1,600**

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		**Total SPH Deciduous**	
	2018	2020	**2018**	**2020**
129.1	0	400	**0**	**400**

Shrub Diversity From Plot Data (SPH)

Site	Ceanothus		Falsebox		Kinnikinnick		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
129.1	400	200	2,000	1,000	0	800	**2,400**	**2,000**

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
129.1	1	1	0	1	2	3	**3**	**5**

6.3.3 Transmission Line Road 130.1 Summary

Transmission line road 130.1 is deactivated and is not drivable. Soils are rapidly draining and coarse with lots of surface rock. This site was grass seeded with a fall rye blend. Lodgepole pine and Douglas fir naturals continue to infill, numbers have increased slightly since 2018 with 3200 sph of lodgepole pine and 600 sph of Douglas fir. The fast growing lodgepole pine range from 15 to 75 cm in height. The Douglas fir range from 5 to 35 cm in height. Black cottonwood numbers have remained constant since 2018 with 400 sph. The number of falsebox sph has decreased since 2018 from 6600 in 2018 down to 1400 in 2020. This may be due to moisture deficits in the hot summer months. Despite the decrease in falsebox numbers shrub diversity has increased with kinnickinnick, willow and blackcap raspberry seeding in naturally since 2018. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 16. 130.1 Plot Photos from 2018 and 2020

Table 10. 130.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		Lodgepole Pine		Spruce		**Total SPH Conifers**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
130.1	200	600	3,000	3,200	400	0	**3,600**	**3,800**

Deciduous Diversity From Plot Data (SPH)

Site	Bigleaf Maple		Black Cottonwood		**Total SPH Deciduous**	
	2018	2020	2018	2020	**2018**	**2020**
130.1	0	0	400	400	**400**	**400**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry		Falsebox		Kinnikinnick		Trailing Blackberry		Willow		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
130.1	0	200	6,600	1,400	0	2,000	200	0	0	400	**6,800**	**4,000**

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
130.1	3	2	1	1	2	4	**6**	**7**

6.3.4 Transmission Line Road 133.1 Summary

Transmission line road 133.1 is deactivated and is not drivable. The soils are coarse and there is lots of surface rock present on the site. This site was grass seeded with a fall rye blend. Lodgepole pine and Douglas fir naturals have infilled and are growing well onsite. There are 800 sph of lodgepole pine and 400 sph of Douglas fir the naturals ranging from 10 to 35 cm in height. Black cottonwood and bitter cherry have also seeded in with 200 sph each. Shrub diversity has increased slightly with falsebox and red raspberry now being present onsite. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 17. 133.1 Plot Photos from 2018 and 2020

Table 11. 133.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		Lodgepole Pine		**Total SPH Conifers**	
	2018	2020	2018	2020	**2018**	**2020**
133.1	0	400	0	800	**0**	**1,200**

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		**Total SPH Deciduous**	
	2018	2020	**2018**	**2020**
133.1	0	200	**0**	**200**

Shrub Diversity From Plot Data (SPH)

Site	Bitter Cherry		Falsebox		Red Raspberry		Trailing Blackberry		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
133.1	0	200	0	200	0	400	200	0	**200**	**800**

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
133.1	0	2	0	1	1	3	**1**	**6**

6.3.5 Transmission Line Road 140.1 Summary

Transmission line road 140.1 is deactivated and is not drivable. Scattered coarse woody debris was added to the road after soils were decompacted. This site has been recolonized heavily by red alders suckering up from the stand that previously occupied the site. The number of red alder sph have not increased significantly from 2018 to 2020 but the alder has grown approximately a meter in height since the original plot data was collected. This site has increased in biodiversity since 2018 with Western red cedar, paper birch, red osier dogwood, red raspberry and willow seeding in. The number of thimbleberry plants has decreased from 3000 sph in 2018 to 1600 sph in 2020. The decrease in number of sph is mainly due to an increase in crown closure from the red alder. The shrubs growing under the canopy of red alder are spindly and this site is expected to become less diverse over time. The Western red cedar is growing ok under the canopy as it is tolerant of low light levels. Moss cover is increasing slowly. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

This site falls within the WHA 2-399 and is required to have road and access trails deactivated and non-drivable by ATV. In 2020 when the access points at this site and inspection site 141.1 were reassessed, they remained non-drivable. The second requirement is that at least 50% of the planted stems within the revegetated portion of the Grizzly Bear WHA 2-399 are native fruit bearing shrubs. This requirement is not required for the road access points due to their close proximity to the Lillooet South FSR. The upland areas have a good mix of berry producing shrubs such as thimbleberry, raspberry and red osier dogwood.

Figure 18. 140.1 Plot Photos from 2018 and 2020

Table 12. 140.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Western Red Cedar		**Total SPH Conifers**	
	2018	2020	**2018**	**2020**
140.1	0	2,000	**0**	**200**

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		Paper Birch		Red Alder		**Total SPH Deciduous**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
140.1	12,000	6,200	0	400	26,400	27,800	**38,400**	**34,400**

Shrub Diversity From Plot Data (SPH)

Site	Red Osier Dogwood		Red Raspberry		Thimbleberry		Willow		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
140.1	0	200	0	200	3,000	1,600	0	200	**3,000**	**2,200**

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
140.1	0	1	2	3	1	4	**3**	**8**

6.3.6 Transmission Line Road 163.1 Summary

Transmission line road 163.1 is not deactivated. The plot was established in the middle road in 2018. When the plot was revisited in 2020 the rebar was found on the side of the road and the original plot center could not accurately be relocated. The plot was re-established off the side of the road. Due to different plot locations and the spur road not being deactivated this site should be dropped from revegetation monitoring program. If the road is no longer required to access the transmission line it should be deactivated. This could be completed by decompacting the road and adding coarse woody debris or something less permanent such as putting boulders at the junction of the spur road and the South Lillooet FSR to block access.

Figure 19. 163.1 Plot Photos from 2018 and 2020

Card: Transmission Line
Stratum: 2018 163.1/Plot: 35/Comments
Sep 25, 2018 02.02.25 PM.jpg

Card: Transmission Line
Stratum: 2020 163.1/Plot: 35A/Comments
Overview photo looks up road from FSR.jpg

6.3.7 Transmission Line Road 237.1 Summary

The plot for transmission line road 237.1 is located within the transmission line ROW but may not require brushing in the future as the ROW was cleared wider here to avoid creating a fringe of standing timber between the transmission line and the Ryan River FSR. The road is deactivated and is not drivable. Coarse woody debris was placed on the road and soils were decompacted. Douglas fir naturals have seeded in from the adjacent mature stands at 8800 sph. This site is dominated by thimbleberry and black cottonwood. The number of sph of thimbleberry has not increased very much but the height and width of the plants has increased significantly covering most of the area. Red alder and Bigleaf maple are also present in the area. The number of bigleaf maple sph have not increased since 2018, this is likely due thimbleberry taking up most of the growing space and creating a shadier growing site. Other new shrub species onsite are willow, high brush cranberry and falsebox. Moss cover is increasing slowly. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 20. 237.1 Plot Photos from 2018 and 2020

Table 13. - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		**Total SPH Conifers**	
	2018	2020	**2018**	**2020**
237.1	0	8,800	**0**	**8,800**

Deciduous Diversity From Plot Data (SPH)

Site	Bigleaf Maple		Black Cottonwood		Red Alder		**Total SPH Deciduous**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
237.1	200	200	200	10,800	0	400	**400**	**11,400**

Shrub Diversity From Plot Data (SPH)

Site	Falsebox		Highbrush Cranberry		Rose Species		Thimbleberry		Willow		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
237.1	0	600	0	400	600	0	11,000	14,000	0	1,600	**11,600**	**16,600**

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
237.1	0	1	2	3	2	4	**4**	**8**

6.3.8 Transmission Line Road 238.1 Summary

Transmission line road 238.1 is deactivated and is not drivable. Coarse woody debris was placed on the deactivated road and soils were decompacted. This site has moderately rocky soils. Douglas fir naturals have seeded in heavily on this site with 14,000 sph of germinants and seedlings. The Douglas fir range from 3 to 15 cm in height. Some dieback of Douglas fir seedlings is expected due to competition for light and nutrients as the deciduous trees and shrub species get larger and take up more nutrients and soil moisture. Black cottonwood has also sprouted since 2018 at 200 sph. The shrub complex has diversified and increased in density. New shrub species on site are falsebox and Douglas spirea. The number of sph of thimbleberry and ceanothus has also increased by 1600 sph for thimbleberry and 800 sph for ceanothus. Moss cover is increasing slowly and is dependent on microtopography and presence of mineral soil No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 21. 238.1 Plot Photos from 2018 and 2020

Table 14. 238.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		**Total SPH Conifers**	
	2018	2020	**2018**	**2020**
238.1	0	14,000	**0**	**14,000**

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		**Total SPH Deciduous**	
	2018	2020	**2018**	**2020**
238.1	0	200	**0**	**200**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry		Ceanothus		Douglas Spirea		Falsebox		Thimbleberry		Trailing Blackberry		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
238.1	0	800	1,200	2,000	0	400	0	5,200	3,200	4,800	800	0	**5,200**	**13,200**

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
238.1	0	1	0	1	3	5	**3**	**7**

6.3.9 Transmission Line Road 239.1 Summary

Transmission line road 239.1 takes off from an existing forestry road. The portion of the road built to access pole 239 is deactivated and looks similar to the other roads in the area regarding natural ingress of trees and shrubs. The plot was established on the active portion of the road this location was likely chosen due to its location being outside of the transmission line ROW. Plot data was collected in 2020 but it is recommended that the site be dropped from the monitoring program as the original plot location is not part of the road that Innergex was required to deactivate and actively being used by industry and recreationalists. There was no increase in species diversity and the total sph for the site has decreased from 2000 sph in 2018 to 800 sph in 2020. A new plot could be established in 2022 to assess the success of the revegetation. The plot data could then be compared to adjacent sites.

Figure 22. 239.1 Plot Photos from 2018 and 2020

Table 15. 239.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Total SPH Conifers	
	2018	**2020**
239.1	**0**	**0**

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		**Total SPH Deciduous**	
	2018	2020	**2018**	**2020**
239.1	800	400	**800**	**400**

Shrub Diversity From Plot Data (SPH)

Site	Thimbleberry		**Total SPH Shrubs**	
	2018	2020	**2018**	**2020**
239.1	1,200	400	**1,200**	**400**

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
239.1	0	0	1	1	1	1	**2**	**2**

6.3.11 Transmission Line Road 245.1 Summary

Transmission line road 245.1 is located on a moderately steep slope and is deactivated. Coarse woody debris was placed on the road, soils are rocky and well drained. This site has increased significantly in biodiversity between 2018 and 2020. Douglas fir naturals have seeded in heavily at 8200 sph, with lesser amounts of Western red cedar infilling at 600 sph. The conifers are still in the germinant/seedling phase and range from 3 to 20 cm in height. Black cottonwood and paper birch are also sprouting onsite with 1000 sph of black cottonwood and 400 sph of paper birch. The emerging shrub complex has increased in biodiversity, sph and height since 2018. Moss cover is increasing slowly and is dependent on microtopography and presence of mineral soil. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 23. 245.1 Plot Photos from 2018 and 2020

Table 16. 245.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		Western Red Cedar		Total SPH Conifers	
	2018	2020	2018	2020	2018	2020
245.1	0	8,200	0	600	0	8,800

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		Paper Birch		Red Alder		Total SPH Deciduous	
	2018	2020	2018	2020	2018	2020	2018	2020
245.1	0	1,000	0	400	1,000	0	1,000	1,400

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry		Ceanothus		Douglas Spirea		Falsebox		Gooseberry		Highbush Cranberry		Red Raspberry		Thimbleberry		Trailing Blackberry		Total SPH Shrubs	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
245.1	0	5,600	0	3,600	0	400	0	1,400	400	0	0	600	0	600	11,000	3,200	400	1,200	11,800	16,000

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		Total Number of Species	
	2018	2020	2018	2020	2018	2020	2018	2020
245.1	0	2	1	2	3	8	4	12

6.3.12 Transmission Line Road 247.1/249.1 Summary

Spur road 247.1/249.1 is deactivated and is not drivable. The plot was established at the junction of the two roads. Soils are rocky and well drained. In 2018 this site was dominated by herbaceous cover and had minimal woody species diversity with only thimbleberry and ceanothus being present in 2018. Conifer and shrub diversity have increased significantly since 2018 with 2000 sph of Douglas fir and 600 sph of bigleaf maple. New shrub species onsite that have infilled naturally include raspberry species, high brush cranberry and Douglas spirea. The Douglas fir and bigleaf maple will eventually require brushing to maintain transmission line security. Moss cover is increasing slowly and is dependent on microtopography and presence of mineral soil. No soil erosion or siltation issues were noted.

Figure 24. 247./249.1 Plot Photos from 2018 and 2020

Table 17. 247./249.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		Total SPH Conifers	
	2018	2020	2018	2020
247.1/249.1	0	2,000	0	2,000

Deciduous Diversity From Plot Data (SPH)

Site	Bigleaf Maple		Total SPH Deciduous	
	2018	2020	2018	2020
247.1/249.1	0	600	0	600

Shrub Diversity From Plot Data (SPH)

Site	Birchleaf Spirea		Blackcap Raspberry		Ceanothus		Falsebox		Highbrush Cranberry		Red Raspberry		Thimbleberry		Total SPH Shrubs	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
247.1/249.1	0	200	0	4,600	1,200	2,000	0	10,800	0	400	0	5,600	7,600	13,000	8,800	36,600

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		Total Number of Species	
	2018	2020	2018	2020	2018	2020	2018	2020
247.1/249.1	0	1	0	1	2	7	2	9

6.3.13 Transmission Line Road 250.1 Summary

Transmission line road 250.1 is deactivated and is not drivable. Large pieces of coarse woody debris were placed across the decompacted road. Soils are rocky and well drained. Douglas fir and Western red cedars have infilled naturally at 16,800 sph and 200 sph respectively. The conifers are still small and some mortality is expected to occur due to competition from the emerging shrub complex. Thimbleberry sph and cover have increased significantly on this site from 1800 sph in 2018 to 5000 sph in 2020. Other new shrub species onsite include falsebox, ceanothus, black cap raspberry and lesser amounts of high brush cranberry and prince's pine. Moss cover is increasing slowly and is dependent on microtopography and presence of mineral soil. No soil erosion or siltation issues were noted and no further revegetation treatments are required.

Figure 25. 250.1 Plot Photos from 2018 to 2020

Table 18. 250.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		Western Red Cedar		**Total SPH Conifers**	
	2018	2020	2018	2020	**2018**	**2020**
250.1	0	16,800	0	200	**0**	**18,800**

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		Red Alder		**Total SPH Deciduous**	
	2018	2020	2018	2020	**2018**	**2020**
250.1	0	3,600	200	0	**200**	**3,600**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry		Ceanothus		Falsebox		Gooseberry		Highbrush Cranberry		Prince's Pine		Thimbleberry		Trailing Blackberry		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
250.1	0	1,000	0	1,200	0	2,600	200	0	0	200	0	200	1,800	5,000	200	0	**2,200**	**10,200**

Number of Speices by Site

44.25	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
250.1	0	2	1	1	3	6	**4**	**9**

6.3.14 Transmission Line Road 255.1 Summary

Transmission line road 255.1 is deactivated, and wood chipping was completed onsite. This site has increased significantly in biodiversity and stem counts for conifers, deciduous trees and shrubs. In the 2018 survey there were no conifers. Douglas fir naturals have seeded in heavily since 2018 with 8600 sph in 2020. Western red cedar has also infilled at 1200 sph and lesser amounts of Western hemlock at 200 sph. The conifer naturals are all still in the germinant/seedling phase and range from 3 to 15 cm in height. Black cottonwood and paper birch have also infilled since 2018 with 1200 sph and 200 sph respectively. The shrub complex has also increased in species diversity and sph. Due to this road being located in the ROW the site will eventually require manual brushing to maintain line security. Moss cover is increasing slowly. No soil erosion or siltation issues were noted.

Figure 26. 255.1 Plot Photos from 2018 and 2020

Table 19. 255.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Douglas Fir		Western Hemlock		Western Red Cedar		Total SPH Conifers	
	2018	2020	2018	2020	2018	2020	2018	2020
255.1	0	8,000	0	200	0	1,200	0	9,400

Deciduous Diversity From Plot Data (SPH)

Site	Black Cottonwood		Paper Birch		Red Alder		Total SPH Deciduous	
	2018	2020	2018	2020	2018	2020	2018	2020
255.1	0	800	0	200	200	0	200	1,000

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry		Ceanothus		Falsebox		Highbush Cranberry		Red Raspberry		Salmonberry		Thimbleberry		Trailing Blackberry		Willow		Total SPH Shrubs	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
255.1	0	3,000	0	600	0	5,400	0	200	200	3,400	0	600	1,000	8,600	600	2,600	0	400	1,800	24,800

Number of Species by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		Total Number of Species	
	2018	2020	2018	2020	2018	2020	2018	2020
255.1	0	3	1	2	3	9	4	14

6.3.15 Transmission Line Road 260.1 Summary

Transmission line road 260.1is deactivated, soils were decompacted and large boulders block the access. This site does not have any conifers growing on it at this time. Bigleaf maple has sprouted as single stems and are growing vigorously onsite. The shrub complex continues to increase in density and species diversity. Due to this site being within the right of way (ROW) of the transmission line the hardwoods will eventually need to be brushed to maintain line security. Moss cover is increasing slowly. No soil erosion or siltation issues were noted.

Figure 27. 260.1 Plot Photos from 2018 and 2020

Table 20. 260.1 - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Total SPH Conifers	
	2018	2020
260.1	0	0

Deciduous Diversity From Plot Data (SPH)

Site	Bigleaf Maple		Black Cottonwood		Total SPH Deciduous	
	2018	2020	2018	2020	2018	2020
260.1	200	600	200	0	400	600

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry		Red Raspberry		Saskatoon		Sitka Alder		Thimbleberry		Total SPH Shrubs	
	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
260.1	0	1,800	1,000	0	200	400	0	200	7,800	8,400	9,000	10,800

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		Total Number of Species	
	2018	2020	2018	2020	2018	2020	2018	2020
260.1	0	0	2	1	3	4	5	5

6.3.16 Ryan Crossing Summary

The Ryan Crossing site is located in a narrow corridor with rich organic soils and low light levels. Western red cedar, a low light tolerant species is seeding n naturally from the adjacent stand. The number of seedlings has increased 600 sph in 2018 to 1000 sph in 2020. Shrub densities have also increased and new species are continuing to infill. No erosion or siltation issues were noted. Increases in moss cover are minimal but soil processes are ongoing due to leaf fall from surrounding hardwoods and shrubs.

Figure 28. Ryan Crossing Photos from 2018 and 2020

Table 21. Ryan Crossing - Vegetation Density and Species Diversity from 2018 to 2020

Conifer Diversity From Plot Data (SPH)

Site	Western Red Cedar		**Total SPH Conifers**	
	2018	2020	**2018**	**2020**
Ryan Crossing	600	1,000	**600**	**1,000**

Deciduous Diversity From Plot Data (SPH)

Site	**Total SPH Deciduous**	
	2018	**2020**
Ryan Crossing	**0**	**0**

Shrub Diversity From Plot Data (SPH)

Site	Blackcap Raspberry		Red Osier Dogwood		Thimbleberry		Trailing Blackberry		**Total SPH Shrubs**	
	2018	2020	2018	2020	2018	2020	2018	2020	**2018**	**2020**
Ryan Crossing	0	600	0	400	4,200	7,400	600	0	**4,800**	**8,400**

Number of Speices by Site

Site	Total Number of Coniferous Species		Total Number of Deciduous Species		Total Number of Shrub Species		**Total Number of Species**	
	2018	2020	2018	2020	2018	2020	**2018**	**2020**
Ryan Crossing	1	1	0	0	2	3	**3**	**4**

6.4. Quadrat Survey Results

The quadrat data has been summarized separately for the civil works sites and transmission line road sites. The data sets were separated for ease of viewing the tables. Quadrat surveys were completed in 2018 (Year 1) and again in 2020 (Year 3). The data from the two quadrat plots was collected as per Section 5.2 of this document. For comparison the percent cover data was averaged and then compared to the averaged data collected in 2018. The two years of data are displayed in below in Figures 22 to 27.

Some sites had small decreases in percent cover in one of the layers. This is to be expected as some plants succumb to site limiting factors such as drought, interplant competition or biotic damage. Decreases in one layer led to increases in other layers. This is typical in developing plant communities and is an indication of a recovering site.

6.4.1 Civil Works Sites Quadrat Survey Results

For the civil works sites the results of the quadrat survey are positive. The data indicates that the percent ground cover is increasing for all layers. In 2018 the herbaceous layer had an average cover of 5%, in 2020 the percent cover has increased to 11%. The average shrub layer has increased from 2% in 2018 up to 6% in 2020. The tree layer had the largest increase in percent cover between the two survey years increasing from <1% in 2018 to 4% in 2020. The average percent cover for all layers combined in 2018 was 7%, in 2020 the average has tripled to 21%. These incremental increases in vegetation cover demonstrate that the planted and natural species are continuing to grow in size and number and occupy more of these reclaimed sites.

Figure 22. Civil Works Sites - Percent Cover of Herbaceous Layer from Quadrat Plot Data

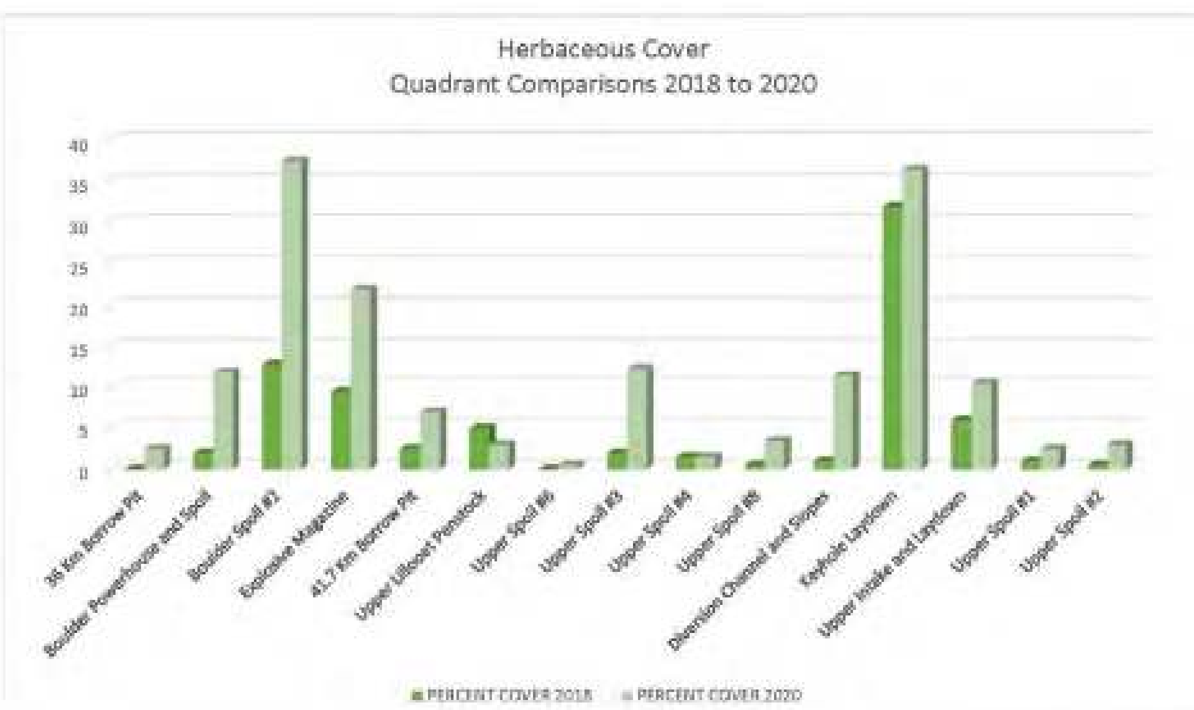


Figure 23. Civil Works Sites - Percent Cover of Shrub Layer from Quadrat Plot Data

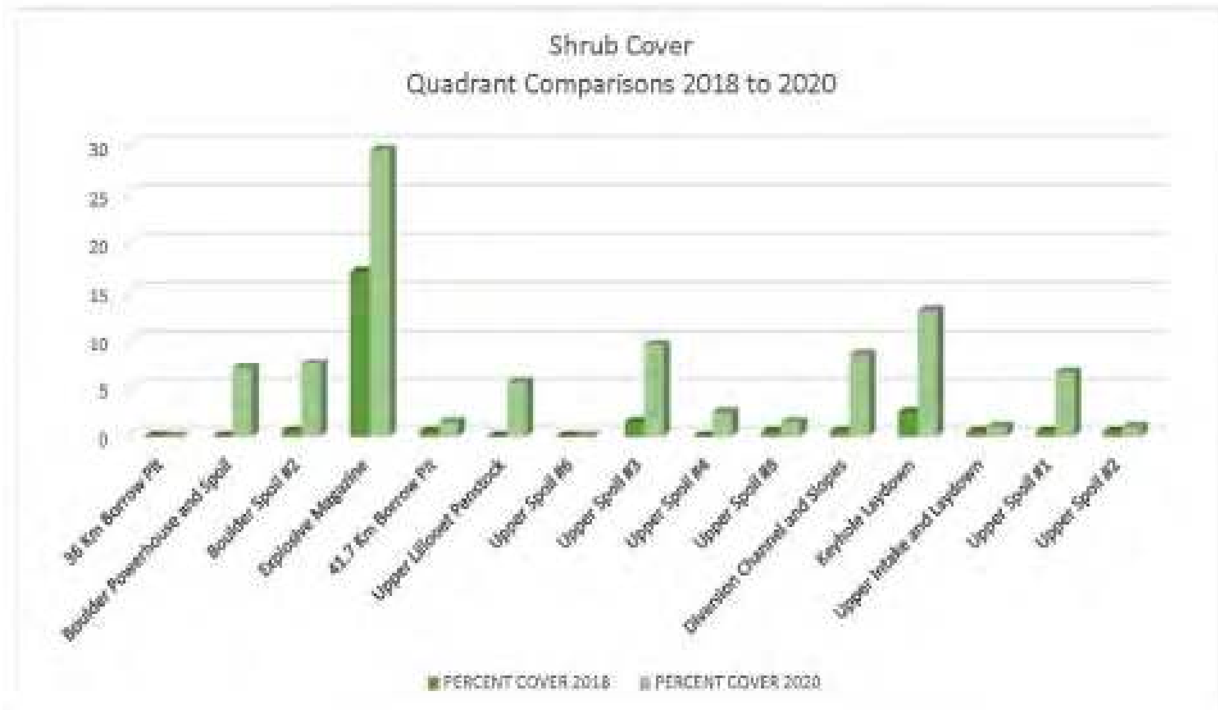
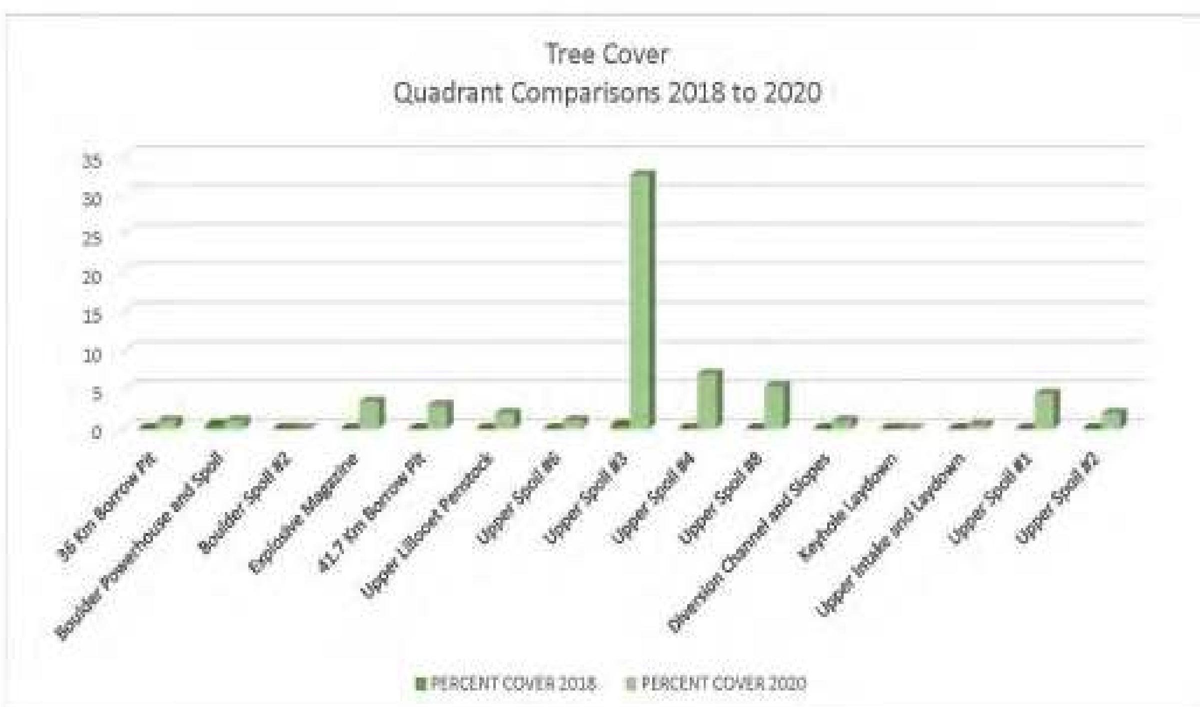


Figure 24. Civil Works Sites - Percent Cover of Tree Layer from Quadrat Plot Data



6.4.2 Transmission Line Quadrat Survey Results

For the transmission line road sites, the results of the quadrat survey are also positive. The herb and shrub layers had the largest gains in percent cover. The tree layer is developing slower but is making small incremental gains. Tree planting activities on the transmission line road sites were completed prior 2018 so any gains in cover for the tree layer have come from natural ingress or trees growing in size since the first set of data was collected. In 2018 the herbaceous layer had an average cover of 10%, the herbaceous layer has more than quadrupled since 2018 to 44% in 2020. The shrub layer also had significant gains in percent cover increasing from 4% in 2018 to 13% in 2020. The tree layer had more modest gains increasing from 1% to 4% in 2020. The slower increase in cover of the tree layer is still positive as tree species grow at a slower rate than the herbaceous and shrub layers that are known for rapid growth during the pioneer stages of site development.

Figure 25. Transmission Line Sites - Percent Cover of Herbaceous Layer from Quadrat Plot Data

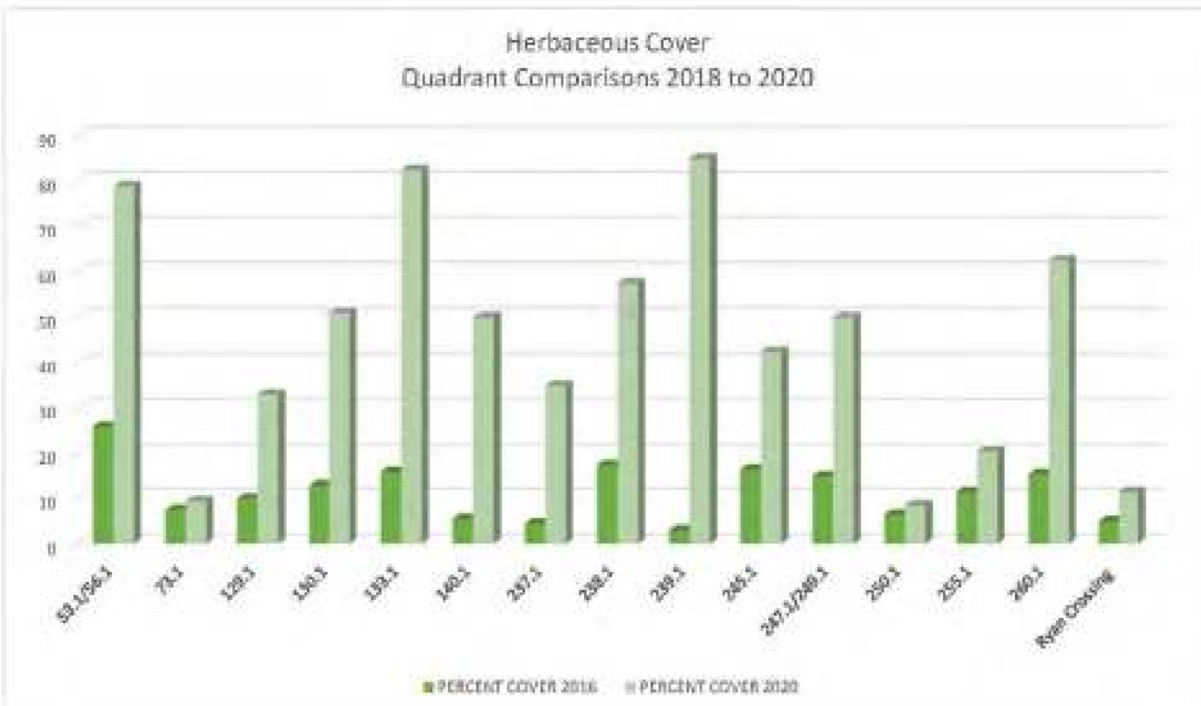


Figure 26. Transmission Line Sites - Percent Cover of Shrub Layer from Quadrat Plot Data

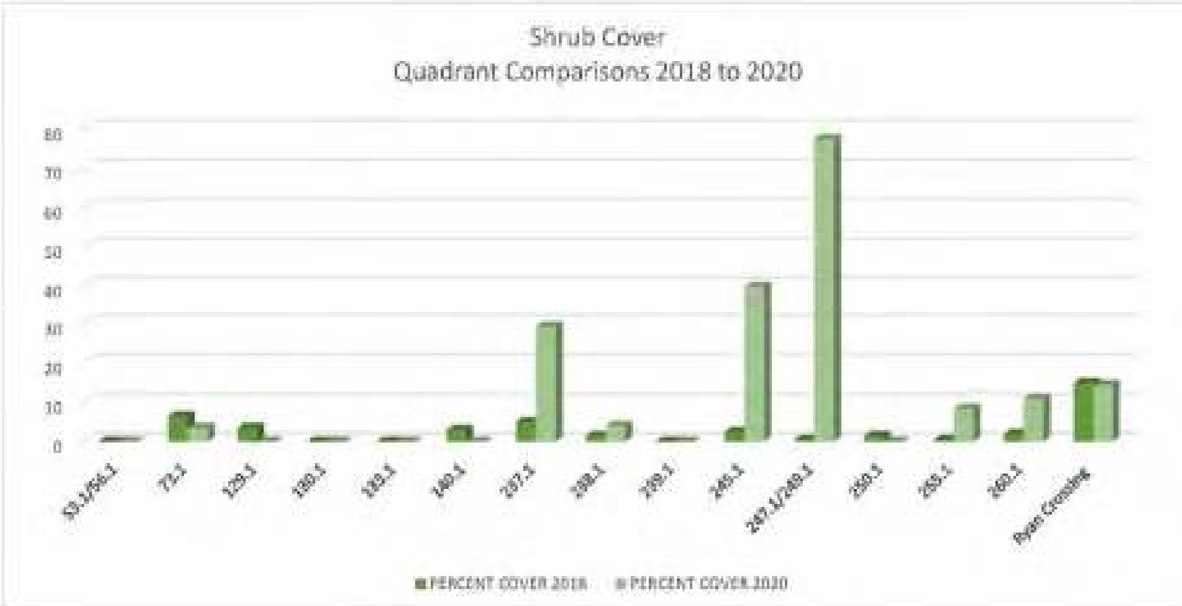
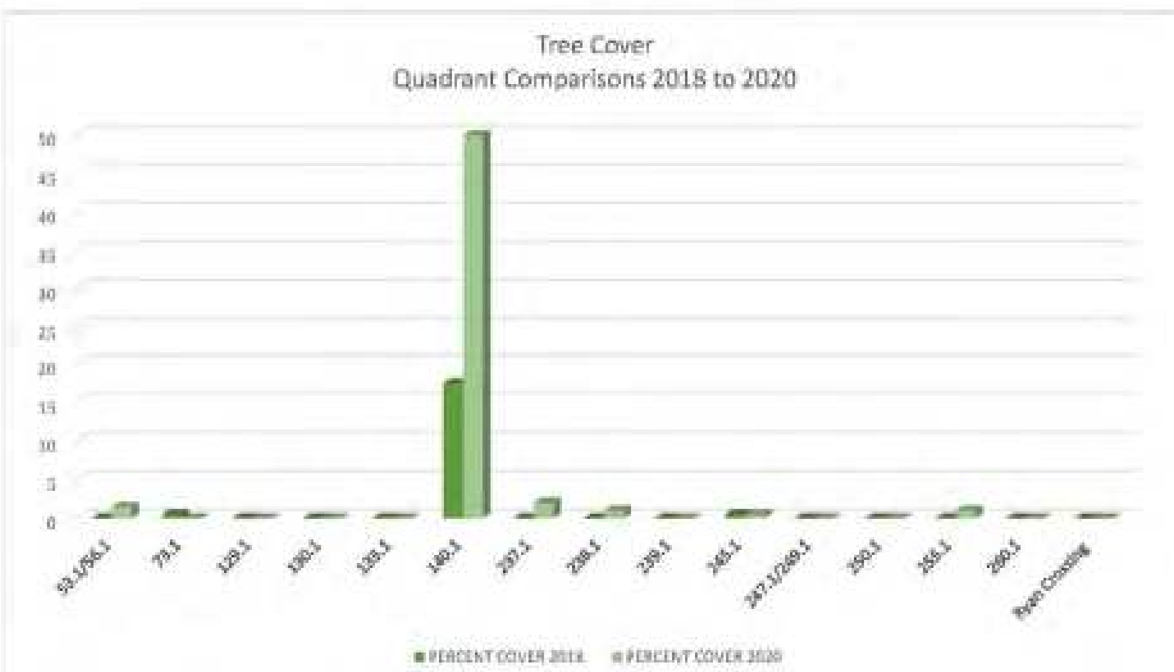


Figure 27. Transmission Line Sites - Percent Cover of Tree Layer from Quadrat Plot Data



6.5. Invasive Plants Monitoring Results

Invasive species are often found on disturbed sites where other native vegetation has not yet colonized the area. Depending on the species and number of plants found on the site these plants may out compete native vegetation for light, water and nutrients and can be unpalatable to wildlife species such as deer and moose. When left untreated invasive species may decrease the productivity of a site

In 2018 small numbers of invasive species were noted while assessing the transmission line and civil work sites. These plants were hand pulled and removed from site by the surveyors. During the 2020 field data collection phase three invasive species were identified on thirteen out of the thirty sites that were visited (see Table 28 for a list of sites and number of plants per site). The invasive plants were not pulled during the 2020 field work due to increased numbers. Population densities are still moderately low but have increased since 2018. Invasive plant species found in 2020 are orange hawkweed (*Hieracium aurantiacum*), bull thistle (*Cirsium vulgare*) and St. Johns-wort (*Hypericum perforatum*). Hawk weed, bull thistle and St. Johns-wort are shade intolerant species and do not typically grow well on sites that have moved past the pioneer phase of reestablishment and into seral stages. With the low number of occurrences, increased plant diversity and native plants continuing to occupy more space, the number of invasive plant occurrences is expected to stabilize and eventually decrease.

These three invasive species are not listed in the I*nvasive Weed Control Act* and *Regulation Schedule A* among the 21 noxious species that require treatment. Industrial users are required to annually report to the Invasive Alien Plant Program (IAPP) any newly discovered invasive plant centers as per Section 3.3.2. of the OEMP. Innergex is not required to treat the invasive plants identified in 2020 as they are not among the 21 noxious species. Reporting the invasive species identified within the project area to IAPP is required.

Table 28. Invasive Species Occurrences by Site

Number of Invasive Plant Occurances by Site			
Site	Orange Hawkweed	St. Johns Wart	Bull Thistle
36 Km Borrow Pit	5		
38 Km Laydown	13	5	
Boulder Powerhouse and Spoil	10		
Camp	15		
Diversion Channel and Slopes	9		
Keyhole Laydown	10		
Upper Lillooet Penstock	1		
163.1			
238.1		5	4
239.1		3	
249.1			3
255.1	5		5
260.1			75

6.6. Species Diversity Results

A complete list of tree and shrub species growing in the ULHP civil work and transmission line sites has been compiled in Table 23. The list includes common and Latin names for clarity. In 2018 there were 23 different tree and shrub species observed across all project sites. This number increased to 39 in 2020. Conifer species diversity increased from 6 species in 2018 to 9 species in 2020. This is in part due to the tree planting activities completed on the civil works sites in the fall of 2018 and natural seeding from adjacent coniferous stands. Deciduous species increased slightly from 3 species in 2018 to 4 species in 2020. Shrubs had the largest increase in species diversity. In 2018 there were 14 different species in 2020 that number has increased to 26 species. All of the new deciduous and shrub species identified in 2020 have seeded in naturally. An increase in species diversity is one of the short-term revegetation goals as noted in Section 4.2 of this report.

Table 29. List of Tree and Shrub Species Observed in the Revegetation Monitoring Plots

Identified Tree and Shrub Species			
Common Name	Latin Name	Present in 2018	Present in 2020
Amabalis Fir	Abies amabalis	✓	✓
Bigleaf Maple	Acer macrophyllum	✓	✓
Birch Leaf Spirea	Spirea betulifolia		✓
Bitter Cherry	Prunus emarginata		✓
Black Cottonwood	Populus balsamifera	✓	✓
Blackcap Raspberry	Rubus occidentalis		✓
Ceanothus	Ceanothus velutinus	✓	✓
Douglas Fir	Pseudotsuga menziesii	✓	✓
Douglas Maple	Acer glabrum		✓
Falsebox	Paxistima myrsinites	✓	✓
Black Gooseberry	Ribes lacustre		✓
Hardhack Spirea	Spirea douglasii		✓
High Brush Cranberry	Viburnum trilobum	✓	✓
Kinnickinnick	Arctostaphylos uva-ursi	✓	✓
Lodgepole Pine	Pinus contorta	✓	✓
Mountain Hemlock	Tsuga mertensiana		✓
Oregon Grape	Mahonia aquifolium	✓	✓
Pacific Dogwood	Cornus nuttallii		✓
Paper Birch	Betula papyrifera		✓
Ponderosa Pine	Pinus ponderosa		✓
Princes Pine	Chimaphila umbellata		✓
Red Alder	Alnus rubra	✓	✓
Red Elderberry	Sambucus racemosa	✓	✓
Red Osier Dogwood	Cornus stolonifera	✓	✓
Red Raspberry	Rubus idaeus	✓	✓
Rose	Rosa species	✓	✓
Salal	Gaultheria shallon	✓	✓
Salmonberry	Rubus spectabilis		✓
Saskatoon	Amelanchier alnifolia		✓
Sitka Alder	Alnus crispa		✓
Sitka Mountain-Ash	Sorbus sitchensis		✓
Spruce	Picea spp	✓	✓
Thimbleberry	Rubus parviflorus	✓	✓
Trailing Blackberry	Rubus ursinus	✓	✓
Trembling Aspen	Populus tremuloides		✓
Vaccinium	Vaccinium spp	✓	✓
Western Hemlock	Tsuga heterophylla	✓	✓
Western Red Cedar	Thuja plicata	✓	✓
Western White Pine	Pinus monticola		✓
Willow	Salix spp	✓	✓

7. Conclusions

All long term revegetation monitoring areas in the ULHP project area that were assessed in 2018 (Year 1) and 2020 (Year 3) are continuing to show development of revegetation processes. On all sites there has been an increase in density of conifers, deciduous trees and shrubs. Biodiversity on almost all sites have continued to increase or stayed the same (see Table 29). Within all sites sampled, pioneering species such as thimbleberry, alder, cottonwood and other early colonizers remain present and numbers are continuing to increase. Percent ground cover has also increased on all sites (see Figures 22 to 27). The plants that were present on the majority of sites are vigorous and healthy and no major disease infestations or damaged areas were observed. No major erosion issues were noted. Slope shaping, soil decompaction and/or other soil treatments allowed for successful root penetration of the newly established vegetation. In conclusion, all of the sites assessed in 2020 are on target to meet project requirements as per Section 5.1 to 5.4 of this document.

Conifer numbers have increased significantly from 2018 (Year 1) to 2020 (Year 3). Many of the conifers are still germinants and their survival is not guaranteed. Until the germinants have grown for a couple of years survival is variable due to small root systems, minimal foliage and limited capabilities to deal with soil moisture deficits in the summer months. If a small to moderate amount of conifer mortality occurs in the future most sites will still be above the target of 1000 sph. Almost all sites that were planted with conifers in 2017 and 2018 are not reliant on germinants to meet target stocking levels. There are two sites within the Civil work sites that were found to be stocked with less than 1000 sph of conifers. Boulder Spoil #2 and Boulder Spoil #7 are located on the Boulder Intake Road. The sites have warm Western aspects and rapidly draining rocky compact soils. Reforestation of these sites was expected to be difficult and take longer to revegetate than other sites within the project.

8. Recommendations

Follow up activities required for the 2020 long term revegetation management program are as follows:

1. Add the Upper Lillooet Penstock area to the annual brushing and danger tree patrols of the ULHP hydro project. This area will not need to be manually brushed for another 3 to 5 years but should be monitored to ensure the integrity of the penstock.
2. Report to the Invasive Alien Plant Program (IAPP) the invasive plant centers identified in the 2020. See table Table 28 for identified invasive species and locations. The identified invasive species do not require treatment at this time.
3. Deactivation of transmission line road site 163.1. This road was not deactivated and remains drivable.

References

Barker, 2019. Memorandum prepared for Tanya Katamay-Smith of for Upper Lillooet River Power Limited Partnership and Boulder Creek Limited Partnership, prepared March 26, 2019 Re: Reforestation summary of October 2018 tree planting for civil works sites at the Upper Lillooet Hydro Project.

Barker, S & A. Litz. 2012. Soil Salvage, Site Reclamation and Landscape Restoration Plan - Upper Lillooet Hydro Project. Consultant's report prepared for Innergex Renewable Energy Inc. Vancouver, BC.

Barker and Guilbride. 2016. Works Plan for Transmission Line Access Roads Deactivation and Rehabilitation - North Zone, March 10, 2016 Consultant's report prepared for Innergex Renewable Energy Inc. Vancouver, BC.

Barker and Guilbride. 2016. Works Plan for Transmission Line Access Roads Deactivation and Rehabilitation - South Zone Consultant's report prepared for Innergex Renewable Energy Inc. Vancouver, BC.

Harwood, A., S. Faulkner, K. Ganshorn, D. Lacroix, A. Newbury, H. Regehr, X. Yu, D. West, A. Lewis, S. Barker and A., Litz. Upper Lillooet Hydro Project Operational Environmental Monitoring Plan. Consultant's Report prepared for the Upper Lillooet River Power Limited Partnership and the Boulder Creek Limited Partnership. March 17, 2017.

Ecofish Research Ltd. 2017. Memorandum from Veronica Woodruff, Alicia Newbury, Deborah Lacroix, on July 6, 2017 Re: Upper Lillooet Hydro Project – Confirmation of Reclamation and Revegetation Works at Designated Riparian Sites.

Faulkner, S., A. Harwood and D. Lacroix. Upper Lillooet Hydro Project Updated Operational Environmental Monitoring Plan. Consultant's memo prepared for the Upper Lillooet River Power Limited Partnership and the Boulder Creek Limited Partnership. February 8, 2018.

McKeachie, I. 2016. Upper Lillooet Hydro Project Master Reclamation Work Plan. Consultant's Report prepared by CRT-ebc for Innergex Renewable Energy Inc. 2016/10/17 Version

Polster, D. 2017. No date. Restoration Progress at Upper Lillooet Power Project.

Staven, W. & A. Litz. 2011. Forest Resource Impact Assessment for the Upper Lillooet Hydro Project. Consultant's report prepared for Innergex Renewable Energy Inc. Vancouver, BC.

ULHP 2013. Construction Environmental Management Plan for the Upper Lillooet Hydro Project

prepared by Innergex Renewable Energy Inc.

Weed Control Act. 1996 RSBC 1996, Chapter 487. Available online at http://www.bclaws.ca/civix/document/id/complete/statreg/96487_01. Accessed on January 17, 2019.

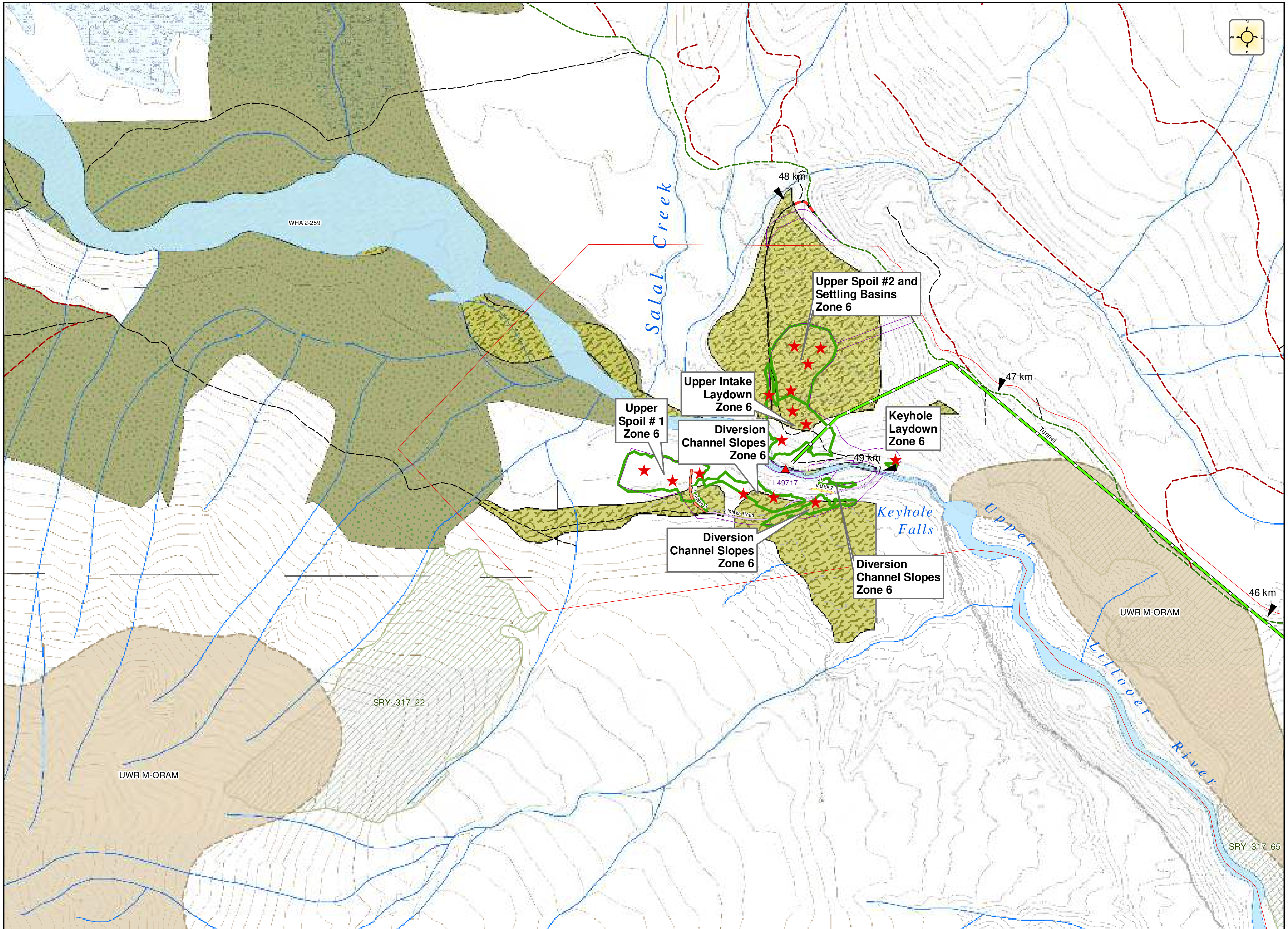
Appendices

Appendix A: Maps of Project Monitoring Program

Appendix B: Civil Works Sites Permanent Monitoring Plot Data Established 2018.

Appendix C: Civil Works Sites Permanent Monitoring Plot Data Established 2020.

Appendix D: Transmission Line Permanent Monitoring Plot Data.



INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type
- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions
- GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
- GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
- GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
- GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
- GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
- Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range
- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 50 100 200 300 400 metres

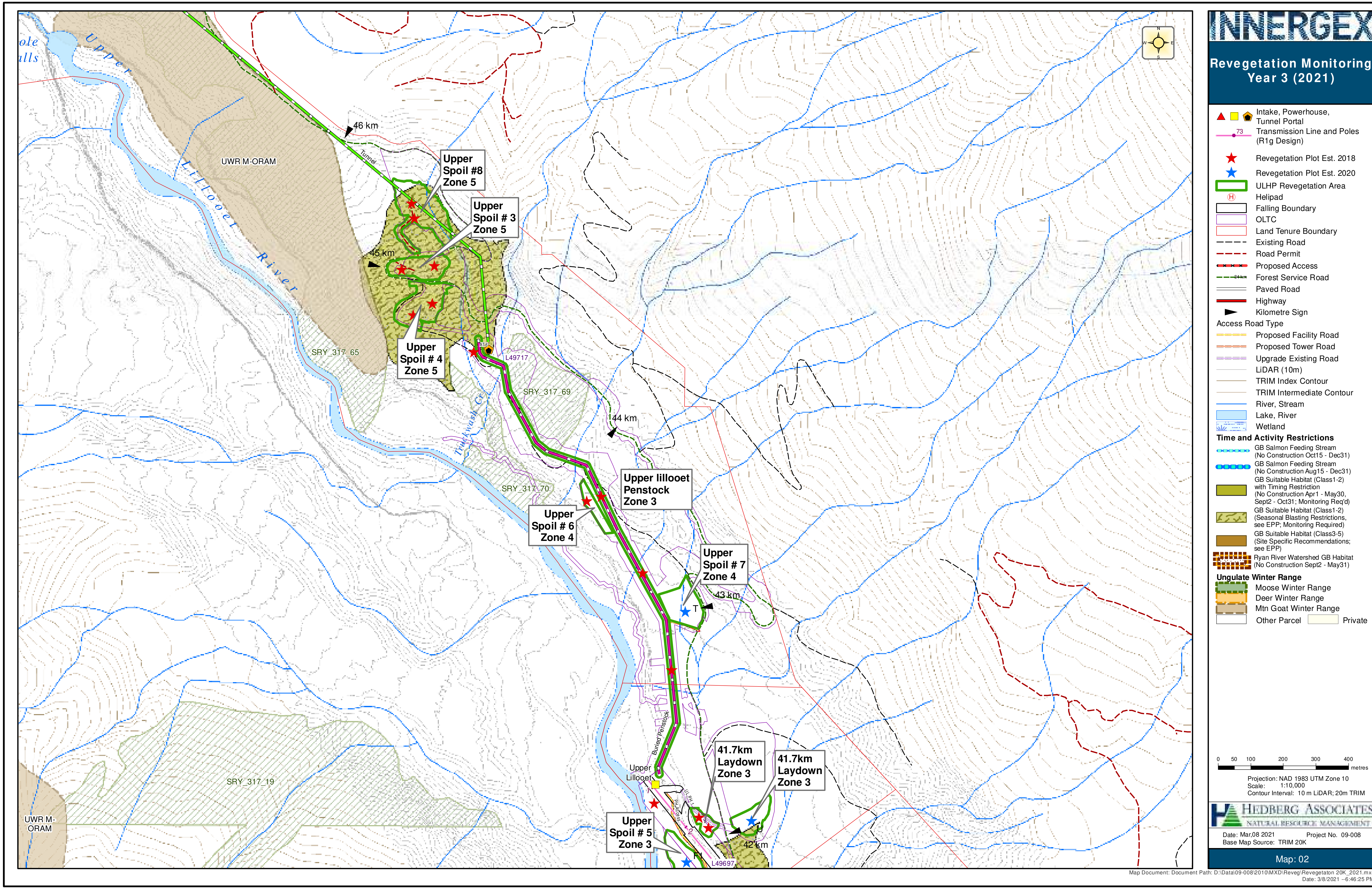
Projection: NAD 1983 UTM Zone 10
Scale: 1:10,000
Contour Interval: 10 m LiDAR; 20m TRIM

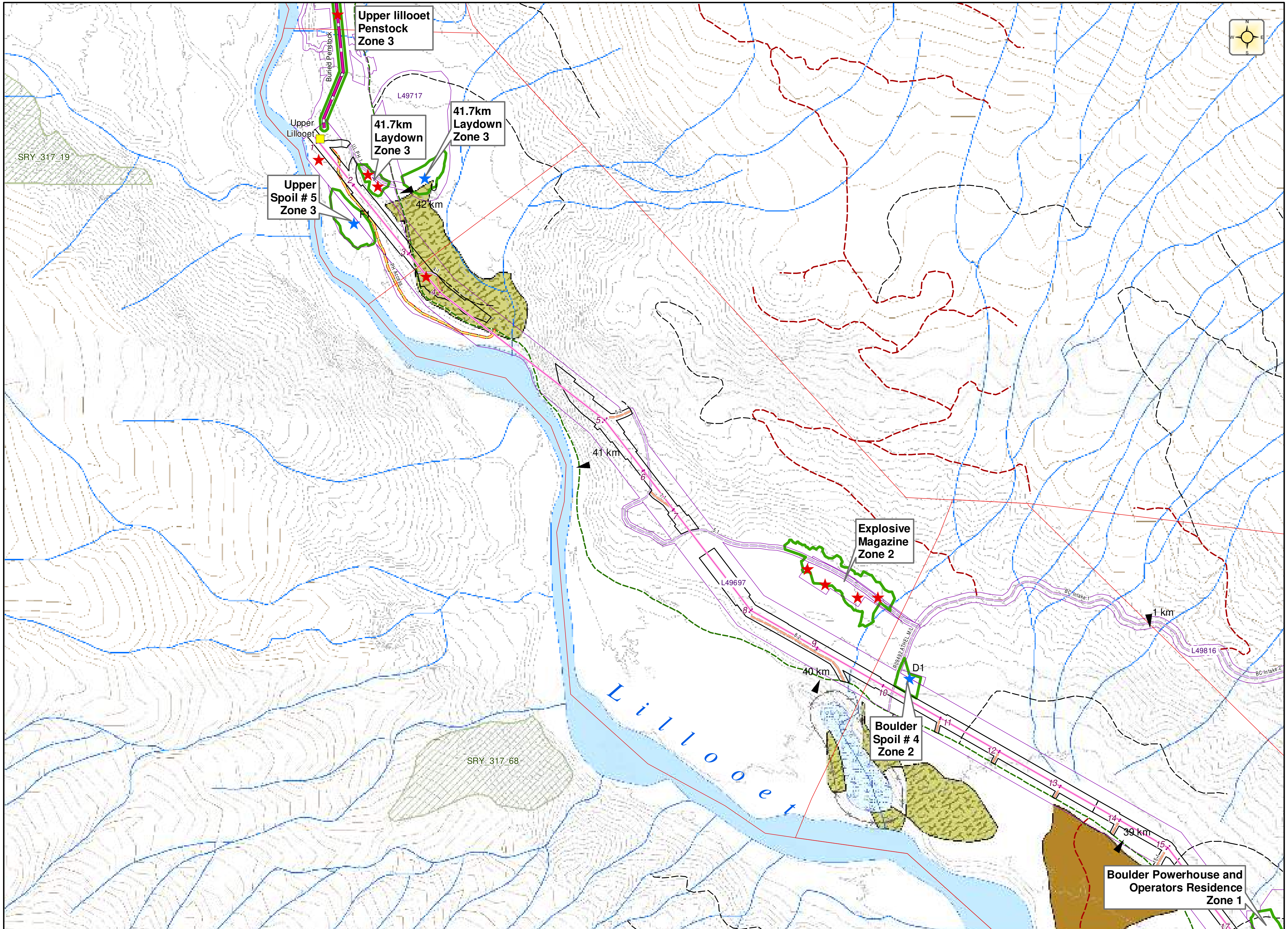
HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 01

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 --6:46:20 PM


INNERGEX
Revegetation Monitoring Year 3 (2021)
Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
Helipad
Falling Boundary
OLTC
Land Tenure Boundary
Existing Road
Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign
Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
TRIM Intermediate Contour
River, Stream
Lake, River
Wetland
Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
Ryan River Watershed GB Habitat (No Construction Sept2 - May31)
Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private
0 50 100 200 300 400 metres
Projection: NAD 1983 UTM Zone 10
Scale: 1:10,000
Contour Interval: 10 m LiDAR; 20m TRIM
HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT
Date: Mar,08 2021
Project No. 09-008
Base Map Source: TRIM 20K
Map: 02
Upper Lillooet River
UWR M-ORAM
46 km
45 km
44 km
43 km
42 km
Tunnel
Upper Spoil #8 Zone 5
Upper Spoil # 3 Zone 5
Upper Spoil # 4 Zone 5
SRY_317_65
SRY_317_69
SRY_317_70
SRY_317_19
L49717
L49697
Upper lillooet Penstock Zone 3
Upper Spoil # 6 Zone 4
Upper Spoil # 7 Zone 4
41.7km Laydown Zone 3
41.7km Laydown Zone 3
Upper Spoil # 5 Zone 3
Upper Lillooet
Buried Penstock
UWR M-ORAM
Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 --6:46:25 PM



INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type

- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions

- GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
- GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
- GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
- GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
- GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
- Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range

- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 50 100 200 300 400 metres

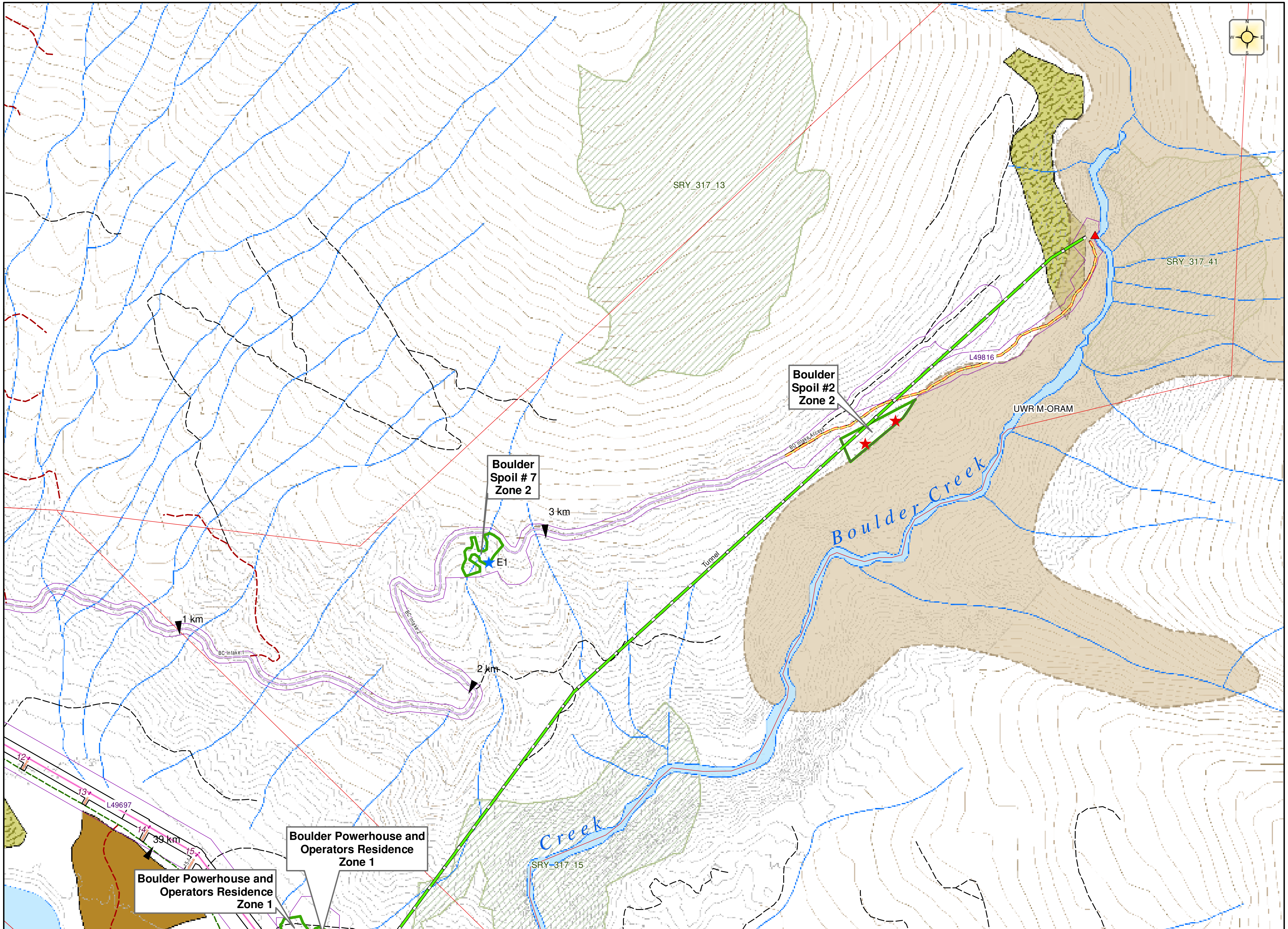
Projection: NAD 1983 UTM Zone 10
Scale: 1:10,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 03

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 --6:46:30 PM



INNERGEX

Revegetation Monitoring Year 3 (2021)

Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
Helipad
Falling Boundary
OLTC
Land Tenure Boundary
Existing Road
Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign

Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
TRIM Intermediate Contour
River, Stream
Lake, River
Wetland

Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private

0 50 100 200 300 400 metres

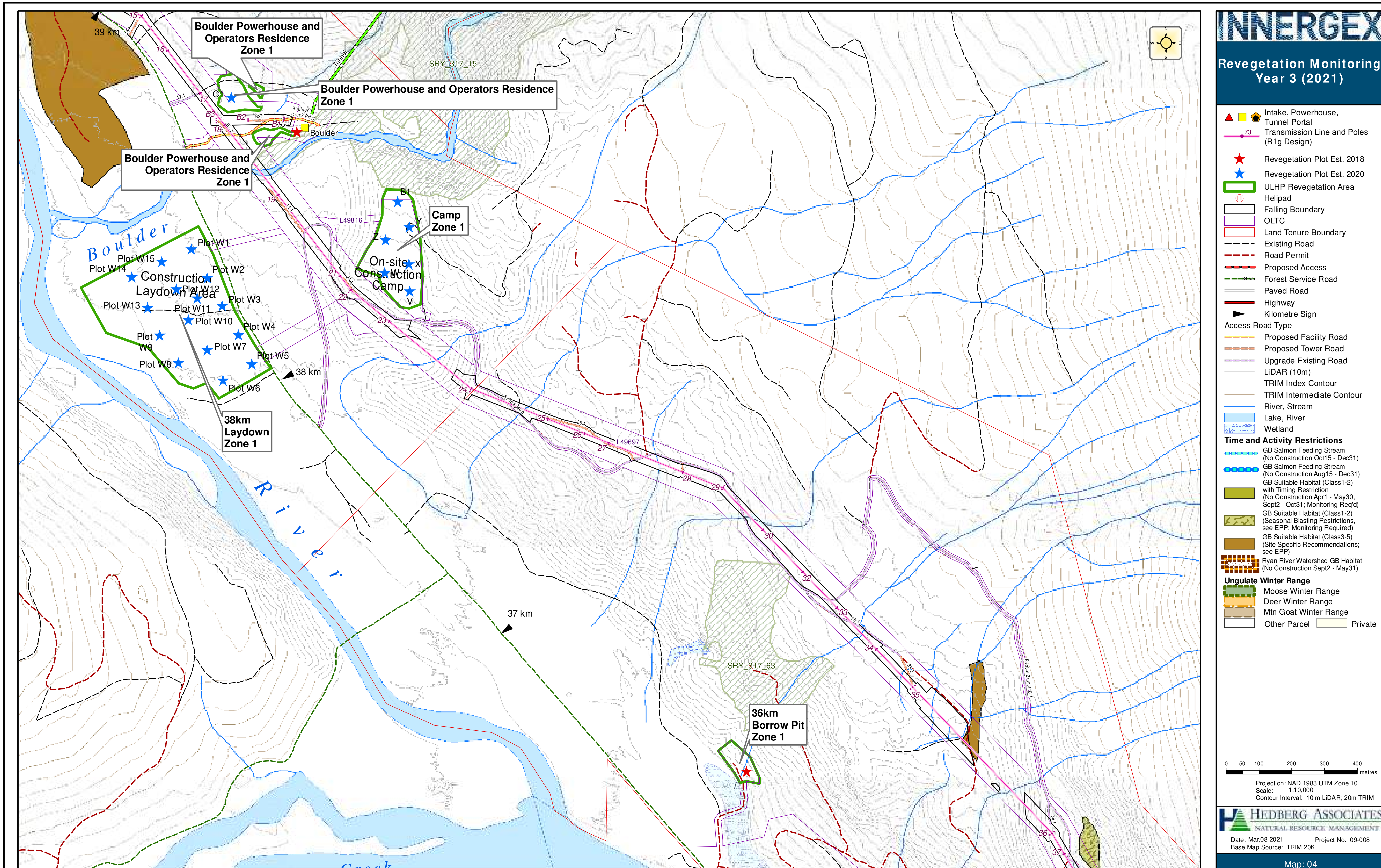
Projection: NAD 1983 UTM Zone 10
Scale: 1:10,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

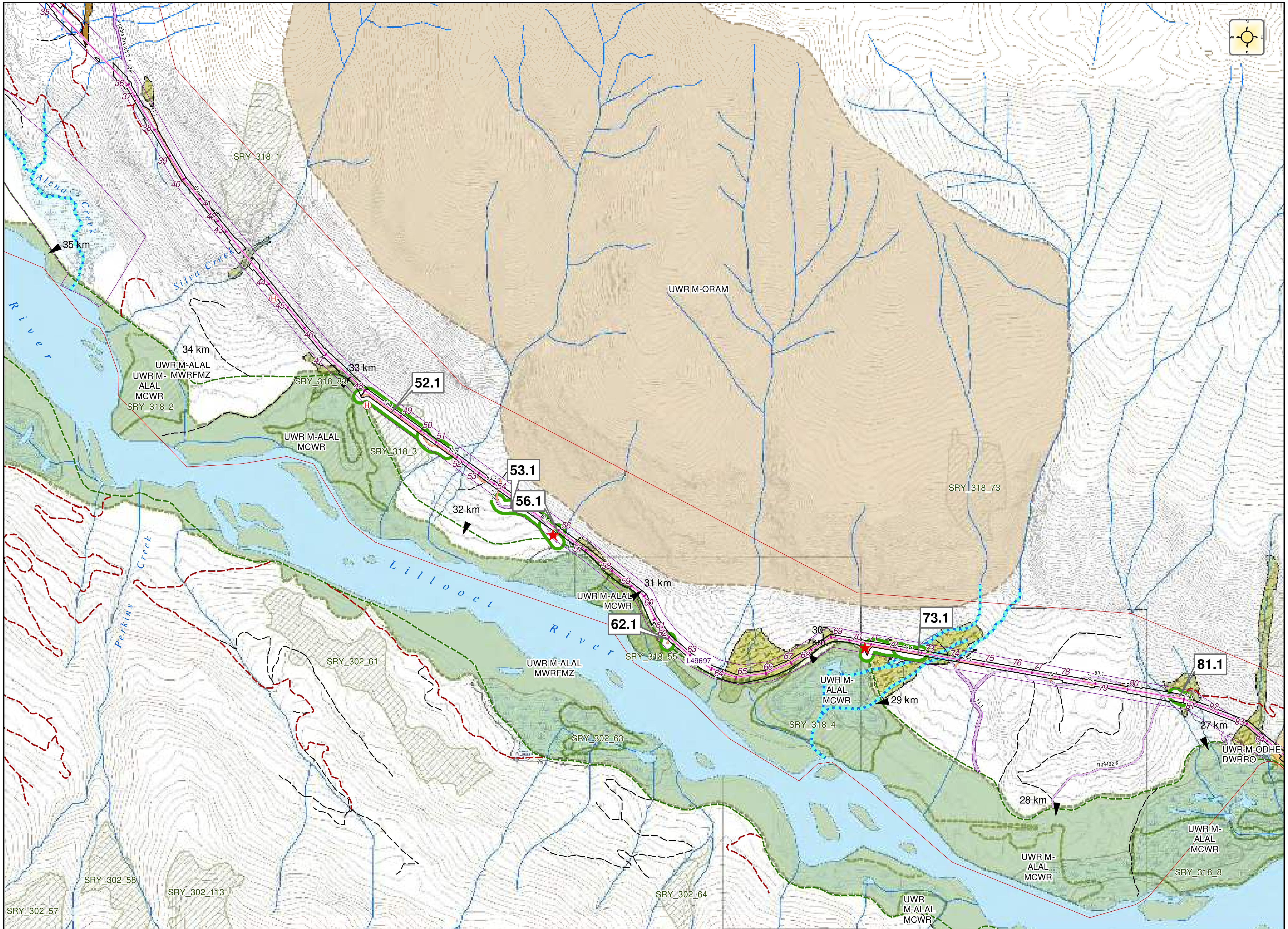
Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 03a

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 --6:46:34 PM



Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 --6:46:42 PM



INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type

- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions

- GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
- GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
- GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
- GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
- GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
- Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range

- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 100 200 400 600 800 metres

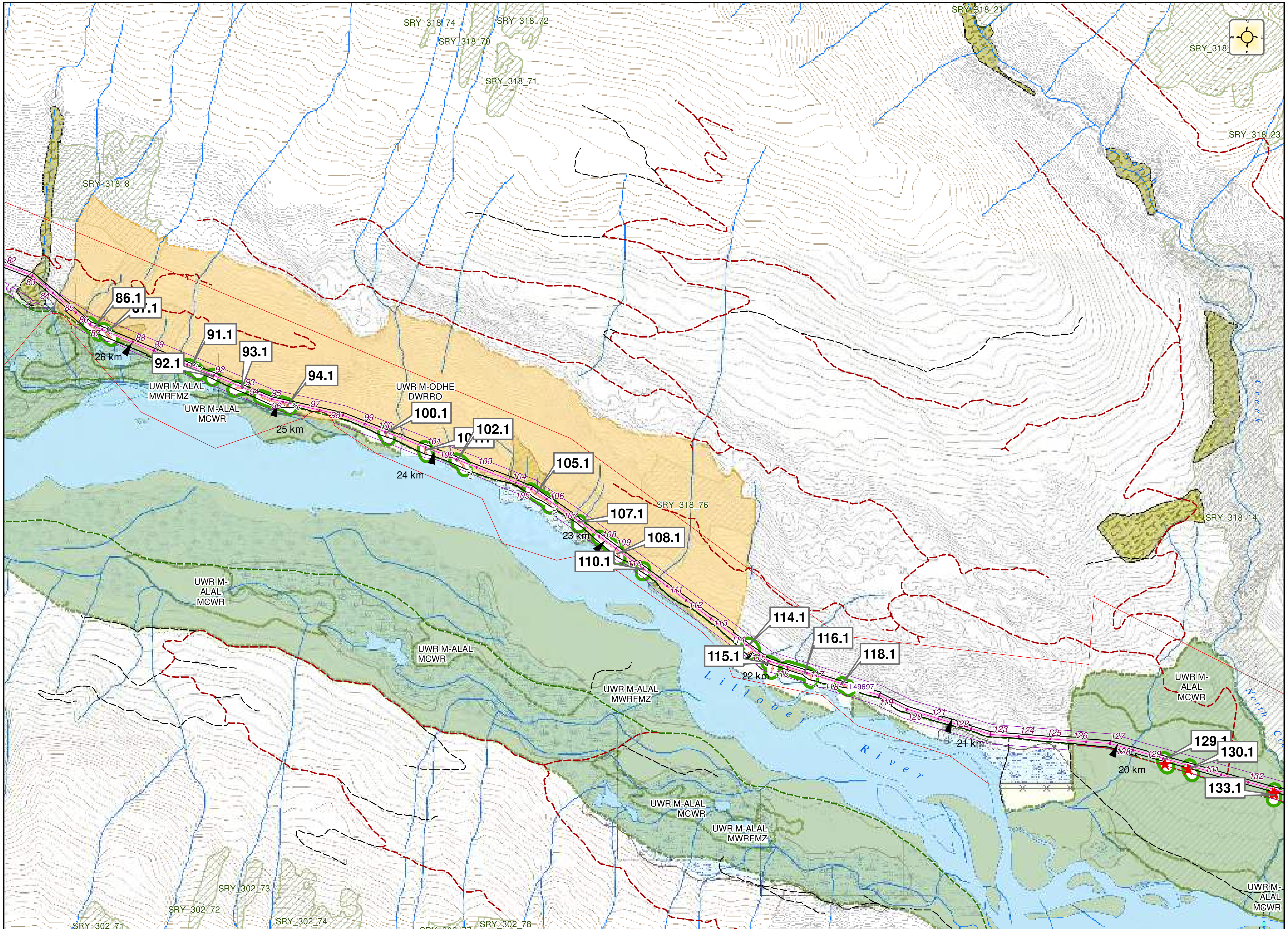
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 05

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 -2:00:47 PM



INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type
- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions
- GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
- GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
- GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
- GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
- GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
- Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range
- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 100 200 400 600 800 metres

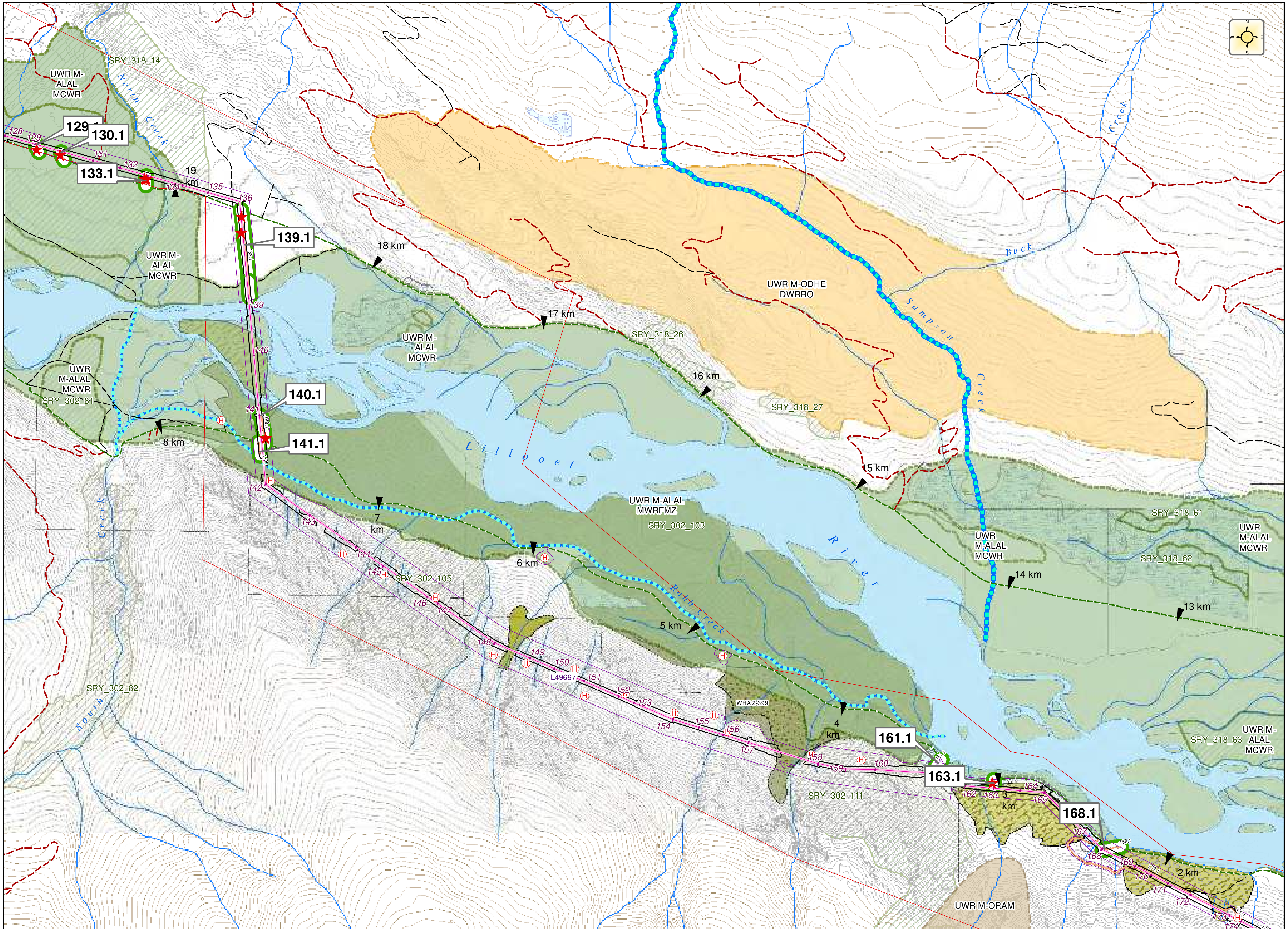
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 06

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 ~2:01:01 PM



INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type

- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions

- GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
- GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
- GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
- GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
- GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
- Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range

- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 100 200 400 600 800 metres

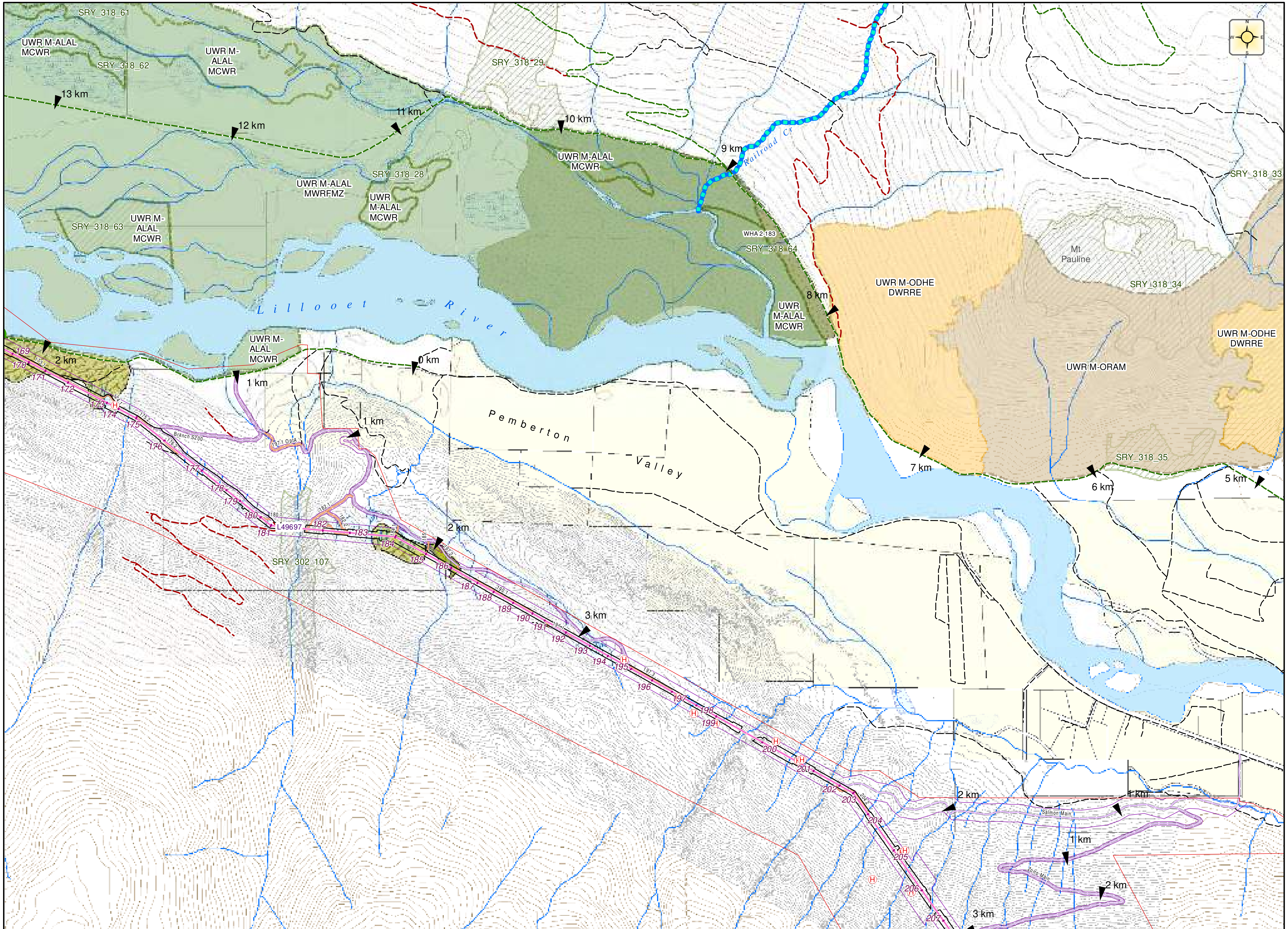
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 07

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 ~2:01:14 PM



INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type

- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions

- GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
- GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
- GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
- GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
- GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
- Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range

- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 100 200 400 600 800 metres

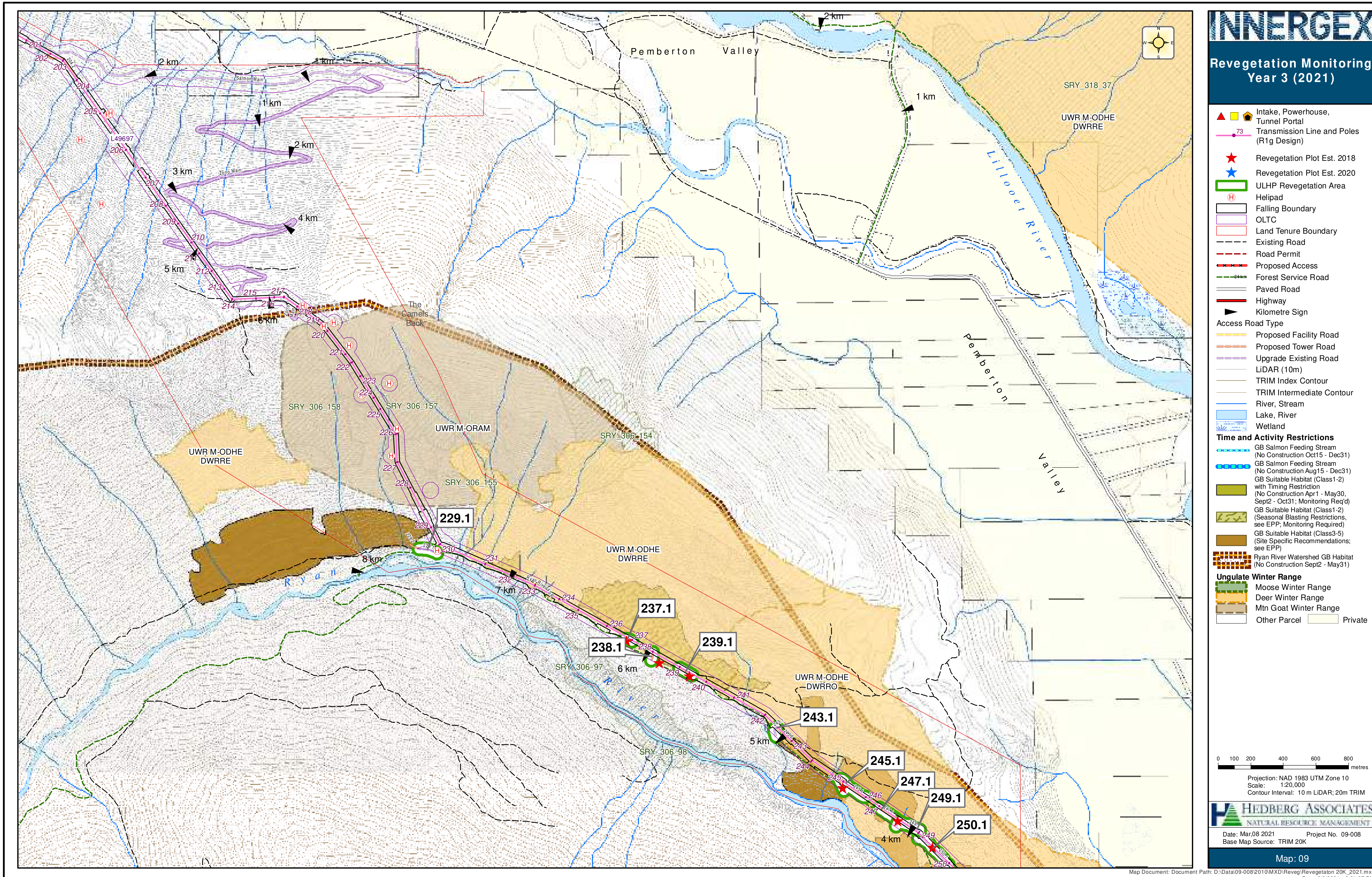
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

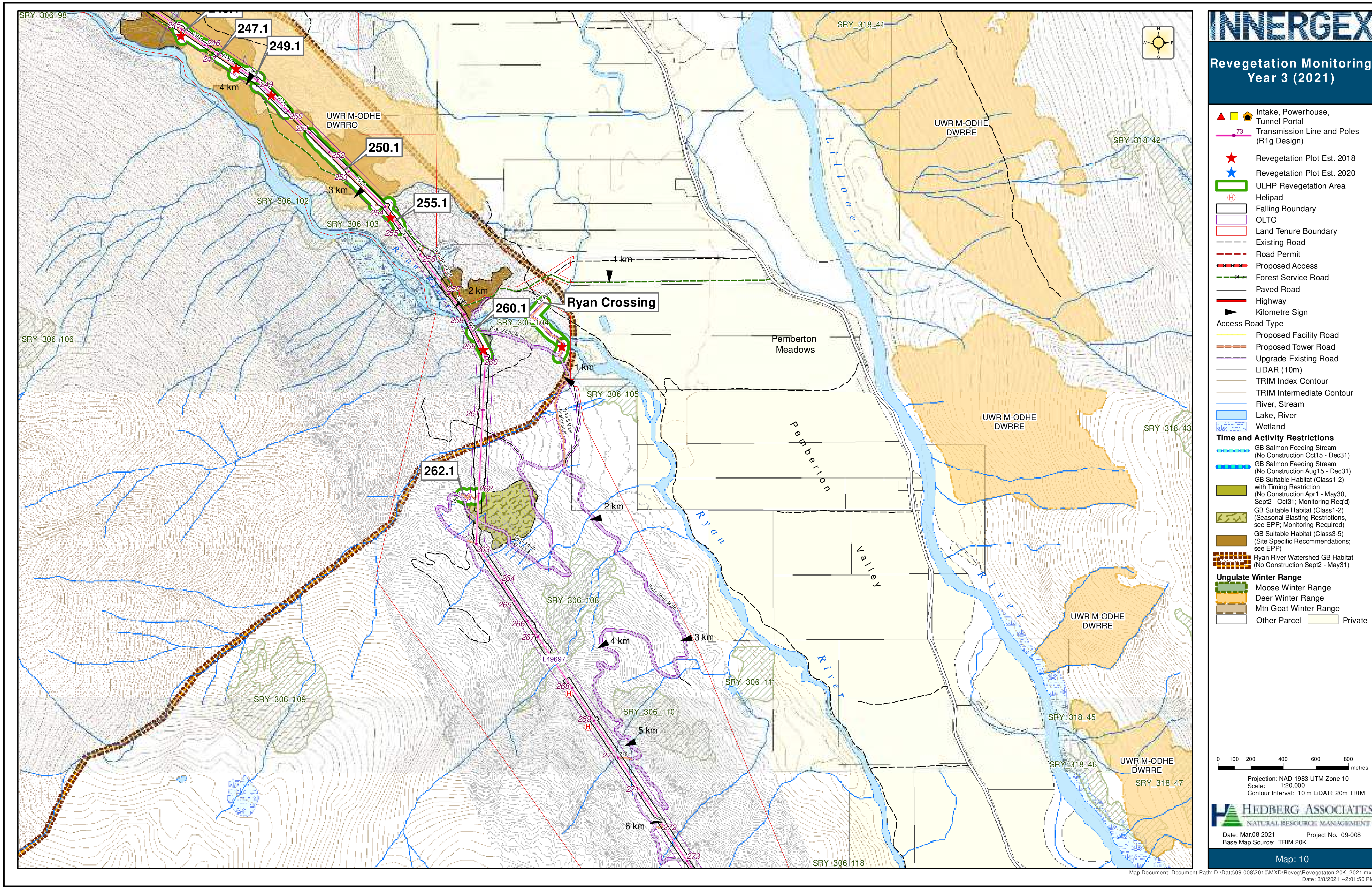
HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

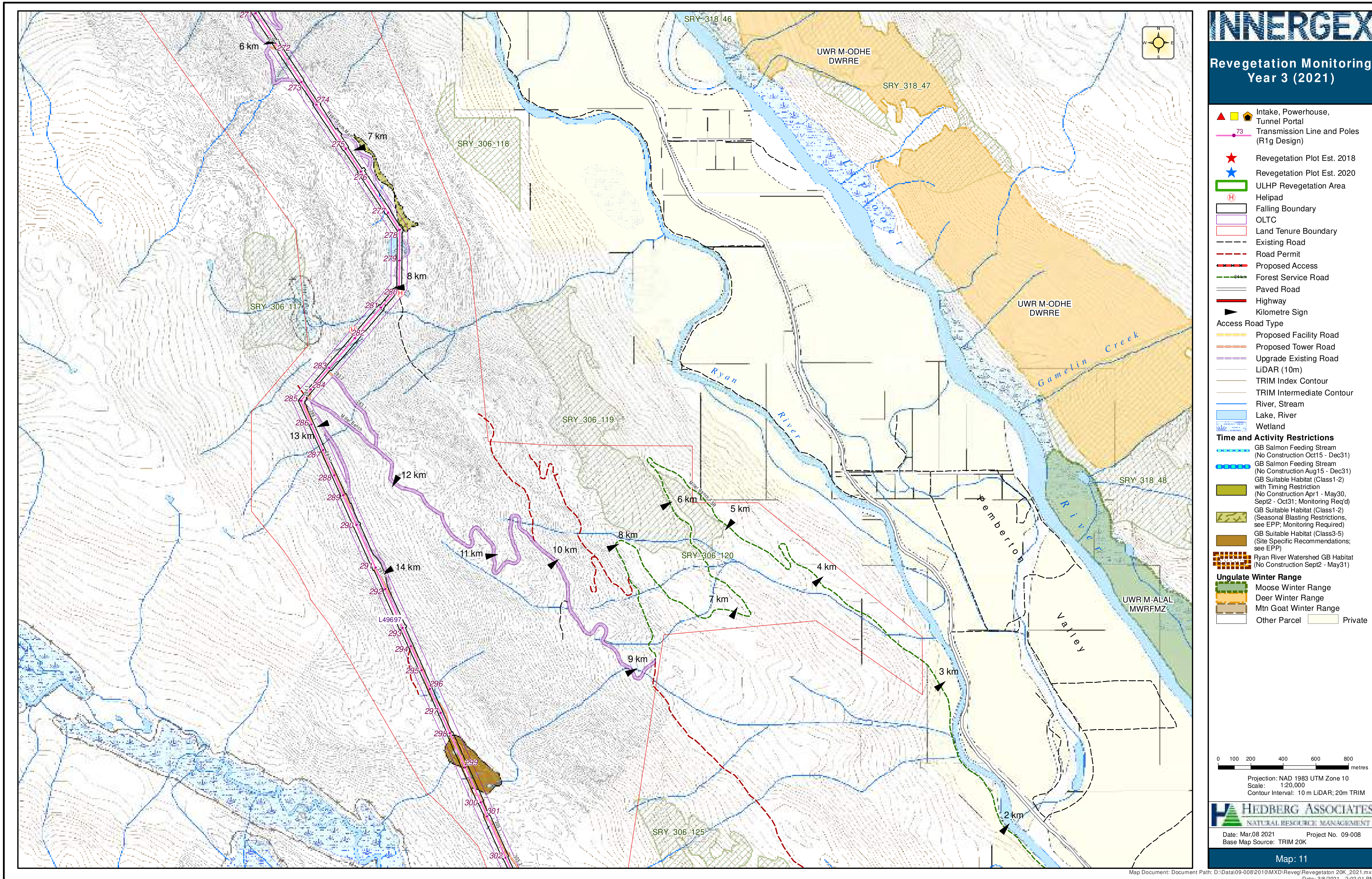
Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

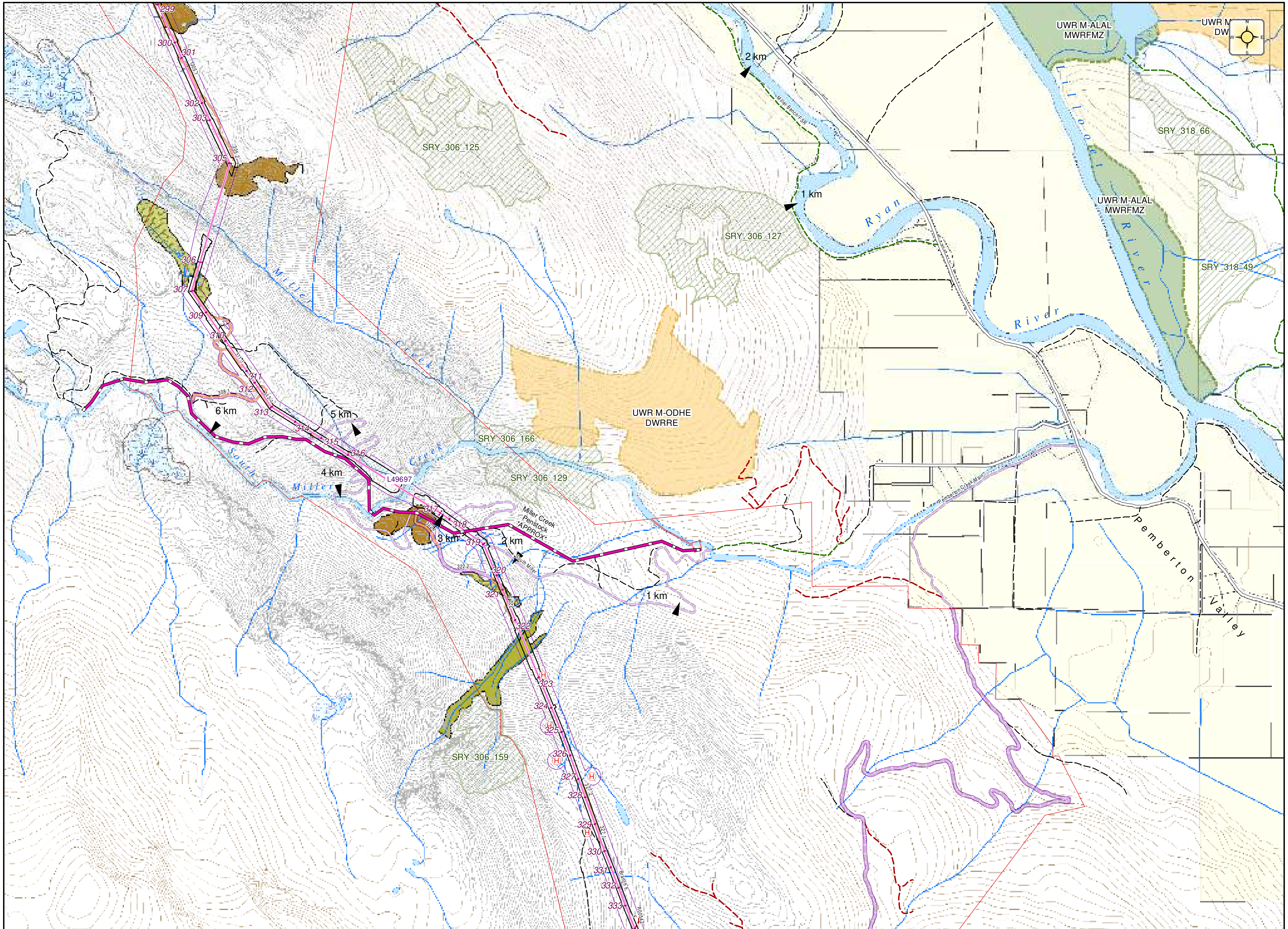
Map: 08

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 ~2:01:25 PM


INNERGEX
Revegetation Monitoring Year 3 (2021)
Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
Helipad
Falling Boundary
OLTC
Land Tenure Boundary
Existing Road
Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign
Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
TRIM Intermediate Contour
River, Stream
Lake, River
Wetland
Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
Ryan River Watershed GB Habitat (No Construction Sept2 - May31)
Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private
0 100 200 400 600 800 metres
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM
HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT
Date: Mar,08 2021
Project No. 09-008
Base Map Source: TRIM 20K
Map: 09
Pemberton Valley
Lillooet River
Ryan River
The Camels Back
Salmon Main
UWR M-ODHE DWRRE
UWR M-ORAM
UWR M-ODHE DWRRO
SRY_306_158
SRY_306_157
SRY_306_154
SRY_306_155
SRY_306_97
SRY_306_98
SRY_318_37
L49697
229.1
237.1
238.1
239.1
243.1
245.1
247.1
249.1
250.1
Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 --2:01:37 PM


INNERGEX
Revegetation Monitoring Year 3 (2021)
Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
Helipad
Falling Boundary
OLTC
Land Tenure Boundary
Existing Road
Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign
Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
TRIM Intermediate Contour
River, Stream
Lake, River
Wetland
Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
Ryan River Watershed GB Habitat (No Construction Sept2 - May31)
Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private
0 100 200 400 600 800 metres
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM
HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT
Date: Mar,08 2021
Project No. 09-008
Base Map Source: TRIM 20K
Map: 10
247.1
249.1
250.1
255.1
260.1
262.1
Ryan Crossing
Pemberton Meadows
Pemberton Valley
Lillooet River
Ryan River
UWR M-ODHE DWRRO
UWR M-ODHE DWRRE
SRY_306_98
SRY_306_102
SRY_306_103
SRY_306_104
SRY_306_105
SRY_306_106
SRY_306_108
SRY_306_109
SRY_306_110
SRY_306_111
SRY_306_118
SRY_318_41
SRY_318_42
SRY_318_43
SRY_318_45
SRY_318_46
SRY_318_47
Ryan South Main
L49697
1 km
2 km
3 km
4 km
5 km
6 km
Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 --2:01:50 PM


INNERGEX
Revegetation Monitoring Year 3 (2021)
Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
Helipad
Falling Boundary
OLTC
Land Tenure Boundary
Existing Road
Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign
Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
TRIM Intermediate Contour
River, Stream
Lake, River
Wetland
Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
Ryan River Watershed GB Habitat (No Construction Sept2 - May31)
Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private
0 100 200 400 600 800 metres
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM
HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT
Date: Mar,08 2021
Project No. 09-008
Base Map Source: TRIM 20K
Map: 11
SRY_318_46
UWR M-ODHE DWRRE
SRY_318_47
SRY_306_118
SRY_306_117
SRY_306_119
SRY_306_120
SRY_318_48
UWR M-ALAL MWRFMZ
SRY_306_125
Lillooet
Ryan River
Gamelin Creek
Pemberton Valley
River
6 km
7 km
8 km
13 km
12 km
14 km
11 km
10 km
9 km
8 km
6 km
5 km
4 km
7 km
3 km
2 km
L49697
Miller Bench
Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 ~2:02:01 PM



INNERGEX

Revegetation Monitoring Year 3 (2021)

- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type

- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions

- GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
- GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
- GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
- GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
- GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
- Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range

- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 100 200 400 600 800 metres

Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

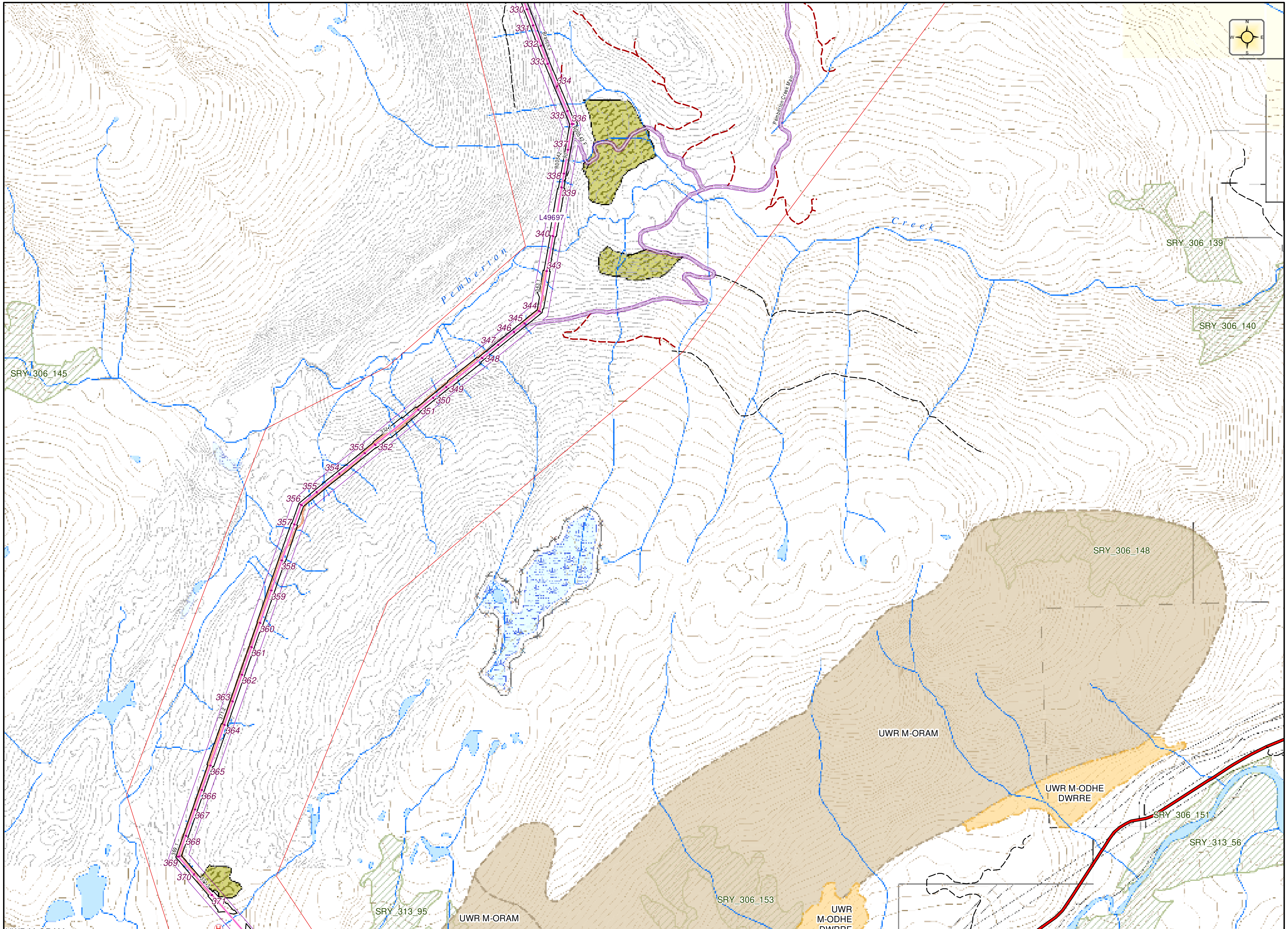
Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 12

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 -2:02:12 PM

INNERGEX

Revegetation Monitoring Year 3 (2021)



- Intake, Powerhouse, Tunnel Portal
- Transmission Line and Poles (R1g Design)
- Revegetation Plot Est. 2018
- Revegetation Plot Est. 2020
- ULHP Revegetation Area
- Helipad
- Falling Boundary
- OLTC
- Land Tenure Boundary
- Existing Road
- Road Permit
- Proposed Access
- Forest Service Road
- Paved Road
- Highway
- Kilometre Sign

Access Road Type

- Proposed Facility Road
- Proposed Tower Road
- Upgrade Existing Road
- LiDAR (10m)
- TRIM Index Contour
- TRIM Intermediate Contour
- River, Stream
- Lake, River
- Wetland

Time and Activity Restrictions

- GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
- GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
- GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
- GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
- GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
- Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range

- Moose Winter Range
- Deer Winter Range
- Mtn Goat Winter Range
- Other Parcel
- Private

0 100 200 400 600 800 metres

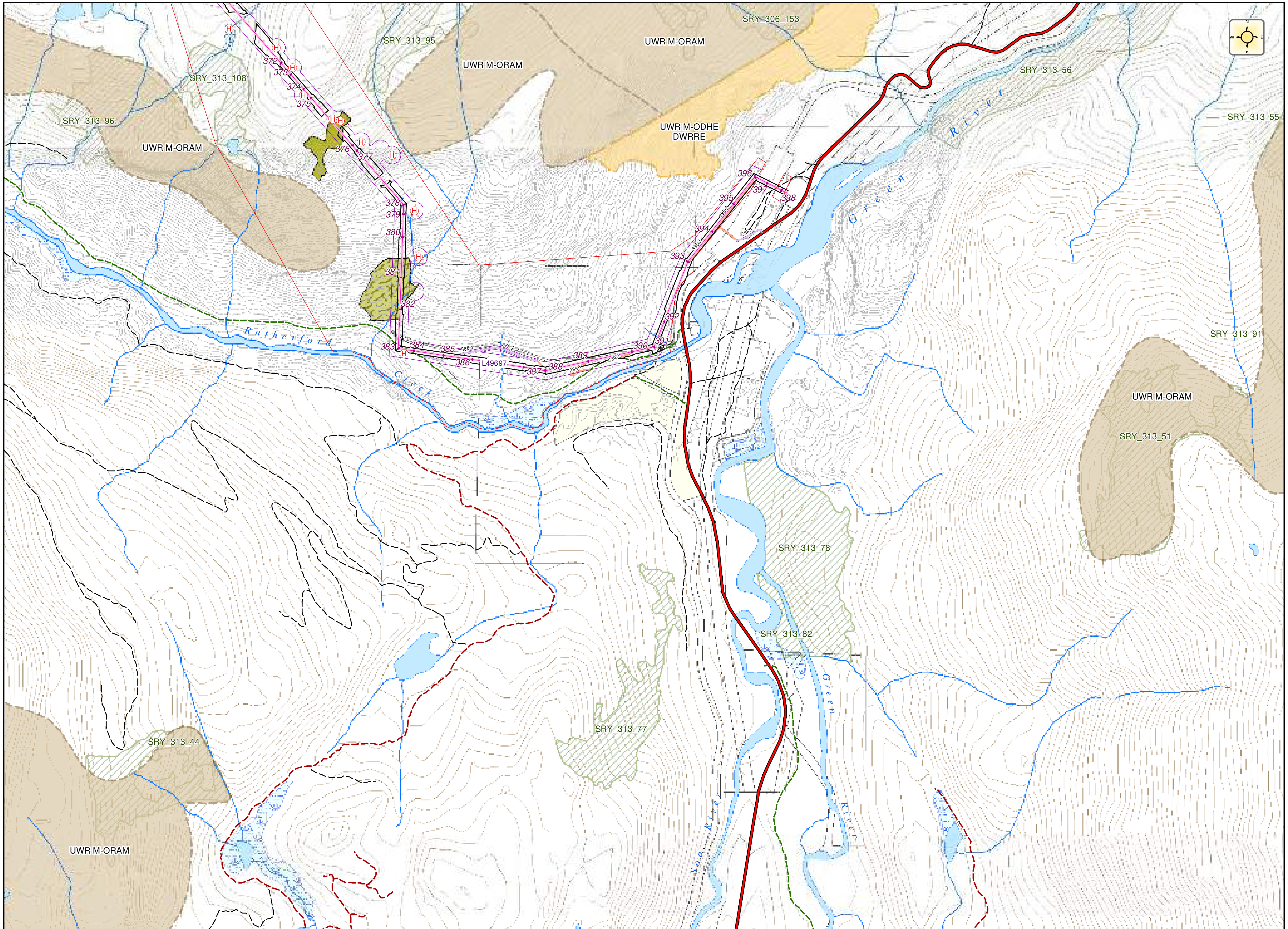
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 13

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 --2:02:21 PM



INNERGEX

Revegetation Monitoring Year 3 (2021)

Intake, Powerhouse, Tunnel Portal
Transmission Line and Poles (R1g Design)
Revegetation Plot Est. 2018
Revegetation Plot Est. 2020
ULHP Revegetation Area
Helipad
Falling Boundary
OLTC
Land Tenure Boundary
Existing Road
Road Permit
Proposed Access
Forest Service Road
Paved Road
Highway
Kilometre Sign

Access Road Type
Proposed Facility Road
Proposed Tower Road
Upgrade Existing Road
LiDAR (10m)
TRIM Index Contour
TRIM Intermediate Contour
River, Stream
Lake, River
Wetland

Time and Activity Restrictions
GB Salmon Feeding Stream (No Construction Oct15 - Dec31)
GB Salmon Feeding Stream (No Construction Aug15 - Dec31)
GB Suitable Habitat (Class1-2) with Timing Restriction (No Construction Apr1 - May30, Sept2 - Oct31; Monitoring Req'd)
GB Suitable Habitat (Class1-2) (Seasonal Blasting Restrictions, see EPP; Monitoring Required)
GB Suitable Habitat (Class3-5) (Site Specific Recommendations; see EPP)
Ryan River Watershed GB Habitat (No Construction Sept2 - May31)

Ungulate Winter Range
Moose Winter Range
Deer Winter Range
Mtn Goat Winter Range
Other Parcel
Private

0 100 200 400 600 800 metres

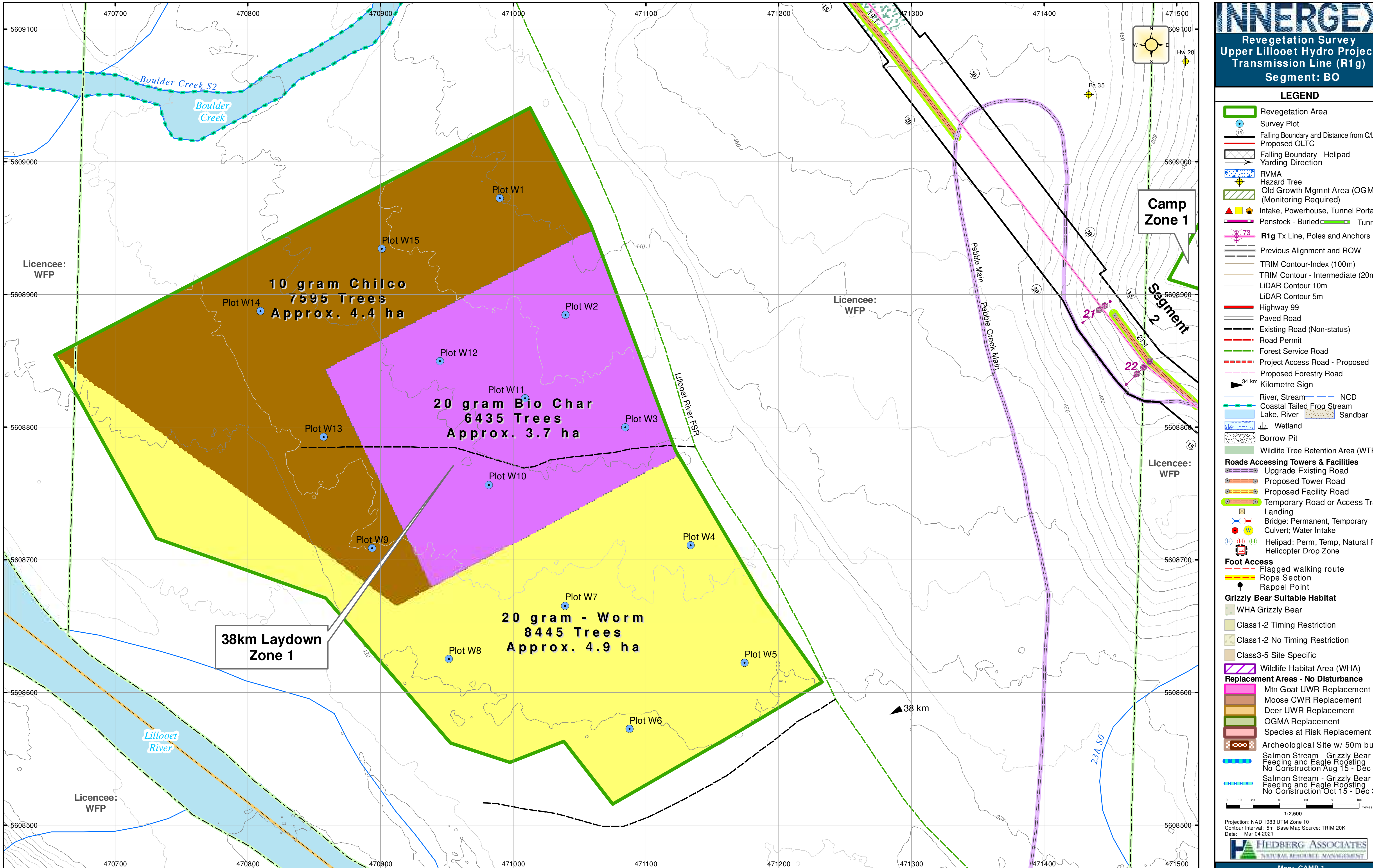
Projection: NAD 1983 UTM Zone 10
Scale: 1:20,000
Contour Interval: 10 m LiDAR; 20m TRIM

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Date: Mar,08 2021 Project No. 09-008
Base Map Source: TRIM 20K

Map: 14

Map Document: Document Path: D:\Data\09-008\2010\MXD\Reveg\Revegetaton 20K_2021.mxd
Date: 3/8/2021 -2:02:29 PM



Document Path: D:\Data\09-008\2010\MXD\Fertilizer\CLEARINGPLAN_TXLine_R1g_2500 Reveg_w_Plots_38km_laydown_Fertilizer_area.mxd
Date Saved: 3/4/2021 9:53:07 AM

Civil Works
36 Km Borrow Pit

Project Information

Project: Longterm Longterm Revegetation
Site: 36Km Borrow Pit
Location: Upper Lillooet Hydro Project
Mapsheet: 36 Km Brw
Net Area: 0.5 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	9,200	81
Douglas Fir	1,200	11
Falsebox	400	4
Red Alder	400	4
Mountain Ash	200	2
Summary:	***11,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	5	15	3.5	55.0
Tree 1	2	95		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Civil Works

Boulder Powerhouse and Spoil

INNERGEX

Project Information

Project: Longterm Longterm Revegetation
Site: Boulder Powerhouse and Spoil
Location: Upper Lillooet Hydro Project
Mapsheet: BO-1
Net Area: 1.4 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	24,000	57
Red Raspberry	7,200	17
Douglas Fir	5,200	12
Thimbleberry	2,800	7
Falsebox	800	2
Lodgepole Pine	600	2
Western Hemlock	600	1
Western Red Cedar	400	1
Western White Pine	200	-
Kinnikinnick	200	0
Red Osier Dogwood	200	0
Willow	200	0
Summary:	***42,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	9	80	8.0	40.0
Herb 2	15	35		
Shrub 1	4	15		
Shrub 2	10	55		
Tree 2	2	15		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Civil Works
Boulder Spoil #2

INNERGEX

Project Information

Project: Longterm Longterm Revegetation
Site: Boulder Spoil #2
Location: Upper Lillooet Hydro Project
Mapsheet: BO-2
Net Area: 1.3 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 2

Inventory Information

Species	*TS (SPH)*	*TS %*
Thimbleberry	2,000	57
Falsebox	900	26
Vaccinium Spp	300	9
Rosa Spp	200	6
Douglas Fir	100	3
Summary:	***3,500***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	42	73	30.0	75.8
Herb 2	33	78		
Shrub 2	15	78		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works

Explosive Magazine

Project Information

Project: Longterm Longterm Revegetation
Site: Explosive Magazine
Location: Upper Lillooet Hydro Project
Mapsheet: Map 3
Net Area: 2.5 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 4

Inventory Information

Species	TS (SPH)	TS %
Red Raspberry	11,650	46
Salix	9,050	36
Thimbleberry	2,150	8
Douglas Fir	1,300	5
Black Cottonwood	500	2
Western Red Cedar	250	1
Bigleaf Maple	150	1
Ceanothus	100	0
Lodgepole Pine	100	0
Sitka Alder	100	0
Summary:	***25,350***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	35	58	18.3	68.1
Herb 2	9	60		
Shrub 1	36	108		
Shrub 2	23	113		
Tree 1	2	29		
Tree 2	5	40		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Civil Works
41.7 Km Borrow Pit

Project Information

Project: Longterm Longterm Revegetation
Site: 41.7 Km Borrow Pit
Location: Upper Lillooet Hydro Project
Mapsheet: BO-1
Net Area: 1.1 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 2

Inventory Information

Species	TS (SPH)	TS %
Red Raspberry	3,800	35
Black Cottonwood	3,400	32
Thimbleberry	1,400	13
Douglas Fir	1,300	12
Spruce	600	6
Oregon Grape	200	2
Summary:	***10,700***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	8	13	4.6	27.3
Herb 2	6	13		
Shrub 1	3	35		
Tree 1	5	65		
Tree 2	1	10		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Civil Works

Upper Lillooet Penstock

INNERGEX

Project Information

Project: Longterm Longterm Revegetation
Site: Upper Lillooet Penstock
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 4.6 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 4

Inventory Information

Species	TS (SPH)	TS %
Red Raspberry	7,850	39
Black Cottonwood	7,800	39
Douglas Fir	2,900	14
Thimbleberry	650	3
Red Alder	450	2
Western Red Cedar	200	1
Willow	150	1
Ceanothus	50	0
Douglas Maple	50	0
Falsebox	50	0
Red Osier Dogwood	50	0
Western White Pine	50	0
Summary:	***20,250***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	5	23	3.5	26.3
Herb 2	1	35		
Shrub 1	7	40		
Shrub 2	4	35		
Tree 1	1	5		
Tree 2	3	20		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Civil Works
Upper Spoil #6

Project Information

Project: Longterm Longterm Revegetation
Site: Upper Spoil #6
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 1 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	7,400	63
Douglas Fir	2,800	24
Western Red Cedar	800	7
Spruce	400	3
Red Alder	200	2
Willow	200	2
Summary:	***11,800***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	1	8	1.0	7.0
Tree 1	1	6		
Tree 2	1	7		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Civil Works
Upper Spoil #3

Project Information

Project: Longterm Longterm Revegetation
Site: Upper Spoil #3
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 1.1 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 2

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	2,900	45
Douglas Fir	1,300	20
Red Raspberry	1,300	20
Amabalis Fir	300	5
Thimbleberry	300	5
Spruce	200	3
Willow	100	2
Summary:	***6,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	13	29	18.2	29.8
Herb 2	12	28		
Shrub 1	10	15		
Shrub 2	9	35		
Tree 1	60	42		
Tree 2	5	30		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works
Upper Spoil #4

Project Information

Project: Longterm Longterm Revegetation
Site: Upper Spoil #4
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 1.6 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 2

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	3,200	49
Douglas Fir	1,100	17
Thimbleberry	800	12
Spruce	700	11
Black Cottonwood	500	8
Amabalis Fir	100	2
Red Osier Dogwood	100	2
Summary:	***6,500***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	1	70	4.4	56.0
Herb 2	2	50		
Shrub 1	5	30		
Tree 1	8	70		
Tree 2	6	60		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works
Upper Spoil #8

Project Information

Project: Longterm Longterm Revegetation
Site: Upper Spoil #8
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 2.2 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 2

Inventory Information

Species	TS (SPH)	TS %
Red Raspberry	12,700	51
Douglas Fir	4,600	19
Black Cottonwood	4,000	16
Amabalis Fir	1,100	4
Falsebox	500	2
Willow	500	2
Western Hemlock	400	2
Western Red Cedar	300	1
Mountain Hemlock	200	1
Ceanothus	100	0
Red Osier Dogwood	100	0
Sitka Alder	100	0
Spruce	100	0
Western White Pine	100	0
Summary:	***24,800***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	2	38	4.2	27.5
Herb 2	5	15		
Shrub 1	3	28		
Tree 1	6	36		
Tree 2	5	21		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Civil Works

Diversion Channel and Slopes

Project Information

Project: Longterm Longterm Revegetation
Site: Diversion Channel and Slopes
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 2.5 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 3

Inventory Information

Species	*TS (SPH)*	*TS %*
Amabalis Fir	2,133	27
Black Cottonwood	1,933	24
Sitka Alder	1,000	13
Salix	933	12
Red Alder	400	5
Spruce	333	4
Vaccinium	267	3
Douglas Fir	133	2
Red Raspberry	133	2
Salal	133	2
Salmonberry	133	2
Sitka Mountain-Ash	133	2
Mountain Hemlock	67	1
Red Elderberry	67	1
Red Osier Dogwood	67	1
Ribes	67	1
Thimbleberry	67	1
Summary:	***8,000***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	9	25	7.0	22.8
Herb 2	14	25		
Shrub 1	9	38		
Shrub 2	8	35		
Tree 1	1	8		
Tree 2	1	6		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works
Keyhole Laydown

Project Information

Project: Longterm Longterm Revegetation
Site: Keyhole Laydown
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 0.1 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	46,400	85
Vaccinium	4,800	9
Amabalis Fir	1,400	3
Red Elderberry	800	1
Ribes	600	1
Willow	400	1
Summary:	***54,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	65	46	33.0	42.0
Herb 2	8	25		
Shrub 2	26	55		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

INNERGEX

Civil Works
Upper Intake and Laydown

Project Information

Project: Longterm Longterm Revegetation
Site: Upper Intake and Laydown
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 2.4 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 4

Inventory Information

Species	TS (SPH)	TS %
Black Cottonwood	16,400	78
Amabalis Fir	2,100	10
Willow	1,050	5
Spruce	350	2
Douglas Fir	300	1
Western Red Cedar	250	1
Red Alder	200	1
Rose	100	0
Lodgepole Pine	50	0
Oregon Grape	50	0
Red Elderberry	50	0
Sitka Alder	50	0
Western Hemlock	50	0
Summary:	***21,000***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	13	7	4.8	11.2
Herb 2	8	7		
Shrub 1	1	15		
Shrub 2	1	10		
Tree 1	1	17		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works
Upper Spoil #1

Project Information

Project: Longterm Longterm Revegetation
Site: Upper Spoil #1
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 2.4 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 3

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	5,467	39
Willow	3,600	26
Sitka Alder	2,667	19
Spruce	1,000	7
Amabalis Fir	533	4
Douglas Fir	200	1
Thimbleberry	133	1
Western Red Cedar	133	1
Red Alder	67	0
Trembling Aspen	67	0
Summary:	***13,867***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	3	15	5.4	31.2
Herb 2	2	15		
Shrub 2	13	42		
Tree 1	5	46		
Tree 2	4	38		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Civil Works

INNERGEX

Upper Spoil #2 & Settling Basin

Project Information

Project: Longterm Longterm Revegetation
Site: Upper Spoil #2
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1
Net Area: 2.8 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 4

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	5,050	67
Douglas Fir	600	8
Amabalis Fir	650	7
Red Raspberry	350	5
Spruce	300	4
Red Alder	250	3
Willow	250	3
Salal	50	1
Thimbleberry	50	1
Summary:	***7,550***	***98***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	5	14	2.4	17.4
Herb 2	1	8		
Shrub 1	2	30		
Tree 1	1	9		
Tree 2	3	27		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

HEDBERG ASSOCIATES NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Species (Percent Cover of Quadrant Plots)	% Cover	Height (cm)
36 Km Borrow Pit	S	Jul 15, 2020 08:19	5607378	472687	Black Cottonwood	46	Herb 1	5	15
					Douglas Fir	6	Tree 1	2	95
					Falsebox	2			
					Mountain Ash	1			
					Red Alder	2			
						57			
						57			
41.7 Km Borrow Pit	M	Sep 8, 2020 14:38	5611549	468613	Black Cottonwood	13	Herb 1	5	10
					Douglas Fir	6	Herb 2	4	15
					Oregon Grape	1	Tree 1	5	65
					Red Raspberry	25	Tree 2	1	10
					Spruce	6			
					Thimbleberry	6			
						57			
	N	Sep 8, 2020 14:55	5611582	468587	Black Cottonwood	21	Herb 1	11	16
					Douglas Fir	7	Herb 2	7	10
					Oregon Grape	1	Shrub 1	3	35
					Red Raspberry	13	Shrub 2	0	50
					Thimbleberry	8			
						50			
						107			
Boulder Powerhouse and Spoil	Q	Sep 8, 2020 11:08	5609341	471322	Black Cottonwood	120	Herb 1	9	80
					Douglas Fir	26	Herb 2	15	35
					Falsebox	4	Shrub 1	4	15
					Kinnikinnick	1	Shrub 2	10	55
					Lodgepole Pine	3	Tree 2	2	15
					Red Osier Dogwood	1			
					Red Raspberry	36			
					Willow	1			
					Thimbleberry	14			
					Western Hemlock	3			
					Western Red Cedar	2			
					Western White Pine	1			
						212			
						212			
Boulder Spoil #2	K	Sep 18, 2020 12:09	5610838	472716	Falsebox	2	Herb 1	7	80
					Rosa Spp	2	Herb 2	60	75
					Thimbleberry	3	Shrub 2	20	110
						7			
	L	Sep 18, 2020 12:30	5610905	472805	Douglas Fir	1	Herb 1	76	65
					Falsebox	7	Herb 2	5	80
					Thimbleberry	17	Shrub 2	10	45
					Vaccinium Spp	3			
						28			
						35			
Diversion Channel and Slopes	008	Aug 14, 2020 11:10	5614012	466028	Amabalis Fir	7	Herb 1	6	38
					Black Cottonwood	12	Herb 2	16	40
					Mountain Hemlock	1	Tree 1	1	8
					Red Alder	6	Tree 2	1	6
					Red Raspberry	2			
					Willow	12			
					Spruce	3			
					Thimbleberry	1			
						44			
	009	Aug 14, 2020 11:31	5613986	466110	Amabalis Fir	5	Shrub 2	8	35
					Black Cottonwood	15			
					Douglas Fir	2			
					Red Osier Dogwood	1			
					Salal	1			
					Willow	2			
					Sitka Alder	6			
					Spruce	2			
					Vaccinium	1			
						35			

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
	013	Aug 14, 2020 11:43	5613983	466234	Amabalis Fir	20	Herb 1	11	12
					Black Cottonwood	2	Herb 2	11	10
					Red Elderberry	1	Shrub 1	9	38
					Ribes	1			
					Salal	1			
					Salmonberry	2			
					Sitka Alder	9			
					Sitka Mountain-Ash	2			
					Vaccinium	3			
						41			
						120			
Explosive Magazine	001	Sep 8, 2020 12:36	5610397	469958	Douglas Fir	6	Herb 2	3	65
					Red Raspberry	57	Shrub 1	90	220
					Willow	133	Shrub 2	32	220
						196			
	002	Sep 8, 2020 13:31	5610442	469890	Black Cottonwood	6	Herb 1	14	33
					Douglas Fir	10	Herb 2	12	30
					Lodgepole Pine	1	Shrub 1	9	50
					Red Raspberry	33	Shrub 2	20	60
					Willow	13	Tree 1	2	48
					Sitka Alder	2			
					Thimbleberry	10			
					Western Red Cedar	4			
						79			
	003	Sep 8, 2020 12:41	5610394	469947	Black Cottonwood	4	Herb 1	17	70
					Douglas Fir	7	Herb 2	12	45
					Lodgepole Pine	1	Shrub 2	17	60
					Red Raspberry	143	Tree 1	1	10
					Willow	18	Tree 2	5	40
					Thimbleberry	3			
						176			
	004	Sep 17, 2020 11:39	5610390	470022	Bigleaf Maple	3	Herb 1	75	70
					Ceanothus	2	Herb 2	8	100
					Douglas Fir	3	Shrub 1	10	55
					Willow	17			
					Thimbleberry	30			
					Western Red Cedar	1			
						56			
						507			
Keyhole Laydown	007	Aug 14, 2020 12:25	5614079	466444	Amabalis Fir	7	Herb 1	65	46
					Red Elderberry	4	Herb 2	8	25
					Red Raspberry	232	Shrub 2	26	55
					Ribes	3			
					Willow	2			
					Vaccinium	24			
						272			
						272			
Upper Intake and Laydown	014	Jul 15, 2020 12:54	5614287	466095	Amabalis Fir	33	Shrub 2	1	10
					Black Cottonwood	273	Tree 1	1	17
					Lodgepole Pine	1			
					Red Alder	4			
					Willow	17			
					Spruce	1			
					Western Red Cedar	3			
						332			
	A	Jul 15, 2020 13:09	5614242	466166	Amabalis Fir	6	Shrub 1	1	15
					Black Cottonwood	46	Tree 1	1	17
					Douglas Fir	1			
					Rose	2			
					Willow	4			
					Spruce	1			
					Western Red Cedar	2			
						62			
	B	Aug 14, 2020 13:06	5614199	466204	Douglas Fir	2	Herb 1	13	7
					Sitka Alder	1	Herb 2	8	7
					Spruce	4			
						7			
	C	Aug 14, 2020 12:50	5614154	466136	Amabalis Fir	3			

HEDBERG ASSOCIATES NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
					Black Cottonwood	9			
					Douglas Fir	3			
					Oregon Grape	1			
					Red Elderberry	1			
					Spruce	1			
					Western Hemlock	1			
						19			
						420			
Upper Lillooet Penstock	H	Oct 20, 2020 13:27	5613021	467886	Black Cottonwood	8		0	0
					Douglas Fir	26			
					Red Alder	9			
					Red Raspberry	32			
					Willow	3			
					Thimbleberry	9			
					Western Red Cedar	1			
						88			
	I	Sep 15, 2020 13:06	5612549	468275	Black Cottonwood	25	Herb 1	8	20
					Douglas Fir	11	Shrub 1	7	40
					Red Osier Dogwood	1	Shrub 2	4	35
					Red Raspberry	121	Tree 2	4	20
					Thimbleberry	4			
					Western Red Cedar	1			
						163			
	O	Sep 15, 2020 13:45	5612325	468415	Black Cottonwood	9	Herb 1	1	25
					Ceanothus	1	Herb 2	1	35
					Douglas Fir	8			
					Falsebox	1			
					Red Raspberry	4			
					Western Red Cedar	2			
						25			
	P	Sep 15, 2020 13:59	5612025	468502	Black Cottonwood	114	Tree 1	1	5
					Douglas Fir	13	Tree 2	1	20
					Douglas Maple	1			
					Western White Pine	1			
						129			
						405			
Upper Spoil #1	010	Aug 14, 2020 10:15	5614048	465825	Amabalis Fir	1	Herb 1	3	15
					Black Cottonwood	11	Herb 2	2	15
					Douglas Fir	1	Shrub 2	13	42
					Red Alder	1			
					Willow	9			
					Spruce	6			
					Thimbleberry	1			
					Western Red Cedar	1			
						31			
	011	Aug 14, 2020 10:20	5614073	465752	Amabalis Fir	3			
					Douglas Fir	2			
					Sitka Alder	1			
					Spruce	3			
					Western Red Cedar	1			
						10			
	012	Aug 14, 2020 10:37	5614057	465895	Amabalis Fir	4	Tree 1	5	46
					Black Cottonwood	71	Tree 2	4	38
					Willow	45			
					Sitka Alder	39			
					Spruce	6			
					Thimbleberry	1			
					Trembling Aspen	1			
						167			
						208			

HEDBERG ASSOCIATES NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
Upper Spoil #2 and Settling Basin	015	Jul 15, 2020 13:20	5614307	466155	Amabalis Fir	2	Herb 1	13	20
					Black Cottonwood	67	Herb 2	1	5
					Douglas Fir	1			
					Red Alder	2			
					Red Raspberry	7			
					Willow	3			
					Spruce	1			
						83			
	016	Aug 14, 2020 13:27	5614378	466205	Amabalis Fir	3	Tree 1	1	9
					Black Cottonwood	7	Tree 2	4	44
					Douglas Fir	2			
					Willow	2			
					Spruce	3			
						17			
	017	Aug 14, 2020 12:47	5614298	466162	Amabalis Fir	7	Herb 1	1	10
					Black Cottonwood	23			
					Douglas Fir	5			
					Red Alder	3			
					Thimbleberry	1			
						39			
	018	Aug 14, 2020 12:48	5614170	466152	Amabalis Fir	1	Herb 1	1	11
					Black Cottonwood	4	Herb 2	1	10
					Douglas Fir	4	Shrub 1	2	30
					Salal	1	Tree 2	1	10
					Spruce	2			
						12			
						151			
Upper Spoil #3	D	Jul 15, 2020 12:08	5613251	467673	Amabalis Fir	1	Herb 1	17	38
					Black Cottonwood	4	Herb 2	5	25
					Douglas Fir	9	Shrub 2	9	35
					Red Raspberry	13	Tree 1	60	42
					Willow	1			
					Spruce	1			
						29			
	E	Jul 15, 2020 12:24	5613276	467777	Amabalis Fir	2	Herb 1	8	20
					Black Cottonwood	25	Herb 2	19	30
					Douglas Fir	4	Shrub 1	10	15
					Spruce	1	Tree 2	5	30
					Thimbleberry	3			
						35			
						64			
Upper Spoil #4	F	Jul 15, 2020 11:26	5613158	467768	Black Cottonwood	3	Herb 1	1	70
					Douglas Fir	8	Herb 2	2	30
					Red Osier Dogwood	1	Herb 2	1	70
					Red Raspberry	21	Tree 1	8	70
					Spruce	3			
					Thimbleberry	8			
						44			
	G	Jul 15, 2020 11:43	5613118	467712	Amabalis Fir	1	Shrub 1	5	30
					Black Cottonwood	2	Tree 2	6	60
					Douglas Fir	3			
					Red Raspberry	11			
					Spruce	4			
						21			
						65			
Upper Spoil #6	J	Sep 15, 2020 12:54	5612564	468266	Black Cottonwood	37	Herb 1	1	8
					Douglas Fir	14	Tree 1	1	6
					Red Alder	1	Tree 2	1	7
					Willow	1			
					Spruce	2			
					Western Red Cedar	4			
						59			
						59			

HEDBERG ASSOCIATES NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
2020 Upper Spoil #8	005	Sep 15, 2020 11:49	5613456	467696	Amabalis Fir	4	Herb 1	2	38
					Black Cottonwood	17	Herb 2	5	15
					Ceanothus	1	Shrub 1	3	28
					Douglas Fir	6	Tree 2	6	16
					Falsebox	5			
					Mountain Hemlock	1			
					Red Osier Dogwood	1			
					Red Raspberry	127			
					Spruce	1			
					Western Red Cedar	3			
					Western White Pine	1			
						167			
	006	Sep 15, 2020 12:04	5613508	467675	Amabalis Fir	7	Tree 1	6	36
					Black Cottonwood	23	Tree 2	3	25
					Douglas Fir	40			
					Mountain Hemlock	1			
					Willow	5			
					Sitka Alder	1			
					Western Hemlock	4			
						81			
						248			
						5051			

Civil Works
38 Km Laydown

Project Information

Project: Longterm Revegetation Monitoring
Site: 38 Km Laydown
Location: Upper Lillooet Hydro Project
Mapsheet: Map 4
Net Area: 15.2 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 15

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	1,573	31
Red Raspberry	1,160	23
Falsebox	667	13
Douglas Fir	653	13
Lodgepole Pine	347	7
Spruce	200	4
Thimbleberry	80	2
Western Red Cedar	80	2
Kinnikinnick	67	1
Blackcap Raspberry	53	1
Red Alder	40	1
Salix	40	1
Amabalis Fir	27	1
Ceanothus	27	1
Red Osier Dogwood	27	1
Saskatoon	13	0
Summary:	***5,053***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	16	46	6.6	33.5
Herb 2	13	37		
Shrub 1	2	28		
Shrub 2	2	13		
Tree 1	2	37		
Tree 2	5	40		

Qualified Forest Professional's Statement		*Affix Professional Seal Here*
Declaration		
Forest Professional	**Date**	

Civil Works
41.7 Km Borrow Pit

Project Information

Project: Longterm Revegetation Monitoring
Site: 41.7 Km Borrow Pit
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 1.1 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	TS (SPH)	TS %	
Black Cottonwood	9,800	39	
Red Raspberry	9,800	39	
Salix	1,800	7	
Thimbleberry	1,800	7	
Douglas Fir	800	3	
Spruce	600	2	
Mountain Hemlock	400	2	
Sitka Alder	200	1	
Summary:	***25,200***	***100***	-

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	6	30	5.0	29.7
Herb 2	10	15		
Shrub 1	5	40		
Shrub 2	7	75		
Tree 1	1	8		
Tree 2	1	10		

Qualified Forest Professional's Statement	
Declaration	
Forest Professional	**Date**

Affix Professional Seal Here

Civil Works

Boulder Powerhouse and Spoil

Project Information

Project: Longterm Revegetation Monitoring
Site: Boulder Powerhouse and Spoil
Location: Upper Lillooet Hydro Project
Mapsheet: BO-1
Net Area: 1.4 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	TS (SPH)	TS %				
Black Cottonwood	24,000	57				
Red Raspberry	7,200	17				
Douglas Fir	5,200	12				
Thimbleberry	2,800	7				
Falsebox	800	2				
Lodgepole Pine	600	1				
Western Hemlock	600	1				
Western Red Cedar	400	1				
Kinnikinnick	200	0				
Red Osier Dogwood	200	0				
Salix	200	0				
Western White Pine	200	0				
Summary:	***42,400***	***100***	***-***	***-***	***0.00***	***-***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	9	80	8.0	40.0
Herb 2	15	35		
Shrub 1	4	15		
Shrub 2	10	55		
Tree 2	2	15		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Civil Works
Boulder Spoil #4

INNERGEX

Project Information

Project: Longterm Revegetation Monitoring
Site: Boulder Spoil #4
Location: Upper Lillooet Hydro Project
Mapsheet: Map 3
Net Area: 0.4 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	5,800	59
Black Cottonwood	1,200	12
Douglas Fir	1,200	12
Spruce	800	8
Thimbleberry	600	6
Falsebox	200	2
Summary:	***9,800***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	14	45	12.7	35.0
Herb 2	11	30		
Shrub 2	13	30		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Civil Works
Boulder Spoil #7

Project Information

Project: Longterm Revegetation Monitoring
Site: Boulder Spoil #7
Location: Upper Lillooet Hydro Project
Mapsheet: BO-3a
Net Area: 1.1 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	TS (SPH)	TS %
Black Cottonwood	15,200	95
Douglas Fir	800	5
Summary:	***16,000***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 2	1	30	4.3	38.3
Tree 1	6	40		
Tree 2	6	45		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works
Camp

Project Information

Project: Longterm Revegetation Monitoring
Site: Camp
Location: Upper Lillooet Hydro Project
Mapsheet: Map 4
Net Area: 6.5 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 6

Inventory Information

Species	TS (SPH)	TS %
Black Cottonwood	1,900	34
Douglas Fir	1,567	28
Falsebox	867	15
Lodgepole Pine	767	14
Red Raspberry	233	4
Western Red Cedar	100	2
Ponderosa Pine	67	1
Birch Leaf Spirea	33	1
Saskatoon	33	1
Thimbleberry	33	1
Summary:	***5,600***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	2	20	3.0	34.5
Herb 2	6	58		
Shrub 2	2	30		
Tree 1	2	30		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Civil Works
Upper Spoil #5

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Spoil #5
Location: Upper Lillooet Hydro Project
Mapsheet: Map 3
Net Area: 1.1 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Raspberry	23,600	92
Black Cottonwood	800	3
Spruce	600	2
Amabalis Fir	200	1
Douglas Fir	200	1
Sitka Alder	200	1
Summary:	***25,600***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	5	7	3.7	20.0
Herb 2	5	40		
Tree 1	1	13		

Qualified Forest Professional's Statement	
	Affix Professional Seal Here
Declaration	
Forest Professional	**Date**

Civil Works
Upper Spoil #7

Project Information

Project: Longterm Revegetation Monitoring
Site: Upper Spoil #7
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2
Net Area: 0.6 Ha

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of Plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	28,800	73
Red Raspberry	6,400	16
Willow	1,400	4
Douglas Fir	1,200	3
Amabalis Fir	800	2
Red Osier Dogwood	200	1
Sitka Alder	200	1
Thimbleberry	200	1
Summary:	***39,200***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 2	1	45	3.0	38.3
Shrub 2	4	30		
Tree 2	4	40		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2020)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
38 km Laydown	W1	Sep 14, 2020 14:21	5608973	470993	Amabalis Fir	1	Herb 1	5	32
					Black Cottonwood	7	Herb 2	7	12
					Douglas Fir	4	Shrub 1	3	30
					Lodgepole Pine	3	Tree 2	1	20
					Red Alder	1			
					Red Raspberry	5			
					Salix	2			
					Thimbleberry	1			
						24			
	W2	Sep 14, 2020 14:35	5608885	471041	Black Cottonwood	1	Herb 1	34	40
					Blackcap Raspberry	2	Herb 2	11	15
					Douglas Fir	4			
					Red Raspberry	23			
						30			
	W3	Sep 14, 2020 15:19	5608803	471090	Douglas Fir	5	Herb 1	8	50
					Falsebox	1	Herb 2	1	65
					Lodgepole Pine	9	Shrub 1	1	40
					Red Raspberry	18	Shrub 2	1	20
					Saskatoon	1			
					Spruce	3			
					Western Red Cedar	1			
						38			
	W4	Sep 14, 2020 15:32	5608715	471140	Black Cottonwood	3	Herb 1	12	40
					Blackcap Raspberry	1	Herb 2	15	30
					Douglas Fir	4	Shrub 1	4	10
					Falsebox	20	Shrub 2	2	5
					Kinnikinnick	4	Tree 1	1	13
					Lodgepole Pine	1			
						33			
	W5	Sep 14, 2020 15:44	5608620	471177	Black Cottonwood	3	Herb 2	30	50
					Douglas Fir	2	Tree 1	2	52
					Falsebox	1			
					Spruce	2			
					Western Red Cedar	1			
						9			
	W6	Sep 14, 2020 12:34	5608574	471087	Black Cottonwood	38	Herb 1	10	24
					Douglas Fir	4	Herb 2	3	17
					Falsebox	2			
					Lodgepole Pine	2			
						46			
	W7	Sep 14, 2020 12:48	5608658	471041	Black Cottonwood	3	Herb 1	15	75
					Douglas Fir	2	Herb 2	36	65
					Falsebox	2			
					Lodgepole Pine	4			
					Red Alder	1			
					Red Raspberry	14			
					Spruce	2			
					Western Red Cedar	2			
						30			
	W8	Sep 14, 2020 13:06	5608622	470953	Black Cottonwood	3	Herb 1	4	12
					Blackcap Raspberry	1	Herb 2	14	52
					Ceanothus	1			
					Douglas Fir	4			
					Falsebox	2			
					Spruce	3			
					Thimbleberry	1			
						15			
	W9	Sep 14, 2020 13:26	5608705	470885	Black Cottonwood	6	Herb 1	5	65
					Douglas Fir	5	Herb 2	1	10
					Falsebox	1			
						12			

HEDBERG ASSOCIATES NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2020)

							Percent Cover of Quadrant Plots		
Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Species	% Cover	Height (cm)
	W10	Sep 14, 2020 15:07	5608761	470987	Douglas Fir	7	Herb 1	8	80
					Falsebox	8	Herb 2	24	85
					Lodgepole Pine	1	Shrub 1	1	30
					Red Raspberry	7			
					Spruce	2			
					Thimbleberry	3			
						28			
	W11	Sep 14, 2020 14:56	5608821	471016	Douglas Fir	2	Herb 1	100	45
					Falsebox	1	Herb 2	24	40
					Kinnikinnick	1			
					Red Raspberry	2			
					Spruce	1			
					Western Red Cedar	1			
						8			
	W12	Sep 14, 2020 14:46	5608852	470946	Black Cottonwood	21	Herb 1	3	30
					Douglas Fir	2	Herb 2	8	40
					Red Raspberry	2	Tree 2	10	53
					Salix	1			
						26			
	W13	Sep 14, 2020 13:38	5608795	470855	Black Cottonwood	5	Herb 1	9	55
					Ceanothus	1	Herb 2	13	38
					Douglas Fir	1			
					Falsebox	5			
					Red Alder	1			
					Red Raspberry	3			
					Spruce	2			
						18			
	W14	Sep 14, 2020 13:53	5608881	470815	Black Cottonwood	17	Herb 1	4	45
					Douglas Fir	1	Herb 2	10	30
					Falsebox	6	Tree 1	2	45
					Lodgepole Pine	3	Tree 2	5	47
					Red Raspberry	3			
					Thimbleberry	1			
						31			
	W15	Sep 14, 2020 14:07	5608935	470899	Amabalis Fir	1	Herb 1	7	45
					Black Cottonwood	11	Herb 2	5	10
					Douglas Fir	2			
					Falsebox	1			
					Lodgepole Pine	3			
					Red Osier Dogwood	2			
					Red Raspberry	10			
					Western Red Cedar	1			
						31			
						379			
41.7 Km Borrow Pit	U	Sep 15, 2020 14:49	5611566	468747	Black Cottonwood	49	Herb 1	6	30
					Douglas Fir	4	Herb 2	10	15
					Mountain Hemlock	2	Shrub 1	5	40
					Red Raspberry	49	Shrub 2	7	75
					Salix	9	Tree 1	1	8
					Sitka Alder	1	Tree 2	1	10
					Spruce	3			
					Thimbleberry	9			
						126			
						126			
Boulder Powerhouse and Spoil	C1	Sep 17, 2020 11:05	5609435	471112	Black Cottonwood	40	Herb 1	1	3
					Douglas Fir	4	Tree 1	4	20
					Falsebox	4			
					Lodgepole Pine	2			
					Thimbleberry	2			
					Western White Pine	1			
						265			

HEDBERG ASSOCIATES NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2020)

							Percent Cover of Quadrant Plots		
Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Species	% Cover	Height (cm)
Boulder Spoil #7	E1	Sep 17, 2020 12:15	5610505	471657	Black Cottonwood	76	Herb 2	1	30
					Douglas Fir	4	Tree 1	6	40
							Tree 2	6	45
						80			
						80			
Boulder Spoil # 4	D1	Sep 17, 2020 11:27	5610158	470110	Black Cottonwood	6	Herb 1	14	45
					Douglas Fir	6	Herb 2	11	30
					Falsebox	1	Shrub 2	13	30
					Red Raspberry	29			
					Spruce	4			
					Thimbleberry	3			
						49			
						49			
Camp	B1	Sep 17, 2020 10:36	5609117	471619	Black Cottonwood	6	Herb 1	4	30
					Douglas Fir	10	Herb 2	4	60
					Falsebox	6			
					Red Raspberry	1			
					Western Red Cedar	3			
						26			
	V	Sep 17, 2020 09:27	5608844	471656	Black Cottonwood	27		0	0
					Douglas Fir	3			
					Falsebox	3			
					Lodgepole Pine	11			
					Red Raspberry	1			
						45			
	W	Sep 17, 2020 09:38	5608900	471580	Black Cottonwood	1	Herb 1	1	3
					Douglas Fir	11	Herb 2	7	65
					Falsebox	8			
						20			
	X	Sep 17, 2020 09:49	5608927	471653	Black Cottonwood	10	Shrub 2	2	30
					Douglas Fir	6			
					Falsebox	7			
					Lodgepole Pine	5			
						28			
	Y	Sep 17, 2020 10:08	5609039	471655	Birch Leaf Spirea	1	Herb 1	3	15
					Black Cottonwood	4	Herb 2	6	50
					Douglas Fir	9	Tree 1	1	25
					Falsebox	2			
					Lodgepole Pine	7			
					Ponderosa Pine	1			
					Red Raspberry	5			
					Thimbleberry	1			
						30			
	Z	Sep 17, 2020 10:25	5609000	471582	Black Cottonwood	9	Herb 1	1	30
					Douglas Fir	8	Tree 1	3	35
					Ponderosa Pine	1			
					Saskatoon	1			
						19			
						168			
Upper Spoil #5	F1	Sep 17, 2020 12:44	5611439	468547	Amabalis Fir	1	Herb 1	5	7
					Black Cottonwood	4	Herb 2	5	40
					Douglas Fir	1	Tree 1	1	13
					Red Raspberry	118			
					Sitka Alder	1			
					Spruce	3			
						128			
						128			

HEDBERG ASSOCIATES NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2020)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
Upper Spoil #7	T	Sep 15, 2020 14:32	5612207	468544	Amabalis Fir	4	Herb 2	1	45
					Black Cottonwood	144	Shrub 2	4	30
					Douglas Fir	6	Tree 2	4	40
					Red Osier Dogwood	1			
					Red Raspberry	32			
					Salix	7			
					Sitka Alder	1			
					Thimbleberry	1			
						196			
						196			
						1391			

Transmission Line Surveys

53.1/56.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 53.1/56.1
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Black Cottonwood	3,000	47
Thimbleberry	2,200	34
Red Raspberry	800	13
Red Osier Dogwood	200	3
Willow	200	3
Summary:	***6,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	90	70	53.7	43.3
Herb 2	68	20		
Tree 2	3	40		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

73.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 73.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 1

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Thimbleberry	16,000	47
Red Raspberry	10,000	30
Black Cottonwood	5,800	17
Falsebox	1,200	4
Douglas Fir	400	1
Willow	400	1
Summary:	***33,800***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	3	10	7	40
Herb 2	16	80		
Shrub 1	8	50		
Shrub 2	7	45		
Tree 1	1	17		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Transmission Line Surveys

129.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 129.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Lodgepole Pine	1,600	40
Falsebox	1,000	25
Kinnickinnick	800	20
Black Cottonwood	400	10
Ceanothus	200	5
Summary:	***4,000***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	60	15	33.0	25.0
Herb 2	6	35		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Transmission Line Surveys

130.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 130.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 2

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Lodgepole Pine	3,200	39
Kinnickinnick	2,000	24
Falsebox	1,400	17
Douglas Fir	600	7
Black Cottonwood	400	5
Willow	400	5
Blackcap Raspberry	200	2
Summary:	***8,200***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	22	15	51.0	17.5
Herb 2	80	20		

Pest / Disease	Host Species	Dead Trees (SPH)	Live Trees (SPH)	% Total Affected	% Conifers Affected	% Host Trees Affected
DSG Western Gall Rust	PLC	200	200	5	200	-

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Transmission Line Surveys

133.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 133.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet:
Net Area:

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Lodgepole Pine	800	36
Douglas Fir	400	18
Red Raspberry	400	18
Bitter Cherry	200	9
Black Cottonwood	200	9
Falsebox	200	9
Summary:	***2,200***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	100	25	82.5	22.5
Herb 2	65	20		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

140.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 140.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet:
Net Area:

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Red Alder	27,800	72
Black Cottonwood	6,200	16
Western Red Cedar	2,000	5
Thimbleberry	1,600	4
Paper Birch	400	1
Red Osier Dogwood	200	1
Red Raspberry	200	1
Willow	200	1
Summary:	***38,600***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Tree 1	100	270	100.0	260.0
Tree 2	100	250		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Transmission Line Surveys

237.1 Road

INNERGEX

Project Information

Project: Longterm Revegetation Monitoring
Site: 237.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Thimbleberry	14,000	38
Black Cottonwood	10,800	29
Douglas Fir	8,800	24
Willow	1,600	4
Falsebox	600	2
High Brush Cranberry	400	1
Red Alder	400	1
Bigleaf Maple	200	1
Summary:	***36,800***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	5	15	22	51
Herb 2	65	60		
Shrub 1	55	45		
Shrub 2	4	50		
Tree 1	1	35		
Tree 2	3	100		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Transmission Line Surveys
238.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 238.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Douglas Fir	14,000	51
Falsebox	5,200	19
Thimbleberry	4,800	18
Ceanothus	2,000	7
Blackcap Raspberry	800	3
Douglas Spirea	400	1
Black Cottonwood	200	1
Summary:	***27,400***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	35	25	21	22
Herb 2	80	35		
Shrub 1	5	25		
Shrub 2	3	25		
Tree 1	1	9		
Tree 2	1	10		

Qualified Forest Professional's Statement	
Declaration	
Forest Professional	**Date**

Affix Professional Seal Here

Transmission Line Surveys

239.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 239.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Black Cottonwood	400	50
Thimbleberry	400	50
Summary:	***800***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	85	40	85.0	40.0
Herb 2	85	40		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

Transmission Line Surveys

245.1 Road

INNERGEX

Project Information

Project: Longterm Revegetation Monitoring
Site: 245.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Douglas Fir	8,200	31
Blackcap Raspberry	5,800	22
Thimbleberry	3,400	13
Ceanothus	2,600	10
Falsebox	1,400	5
Trailing Blackberry	1,200	5
Black Cottonwood	1,000	4
High Brush Cranberry	600	2
Red Raspberry	600	2
Western Red Cedar	600	2
Douglas Spirea	400	2
Paper Birch	400	2
Summary:	*26,200*	*100*

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	40	20	33	34
Herb 2	45	20		
Shrub 1	40	50		
Shrub 2	40	70		
Tree 1	1	10		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Transmission Line Surveys

245.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 245.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	*TS (SPH)*	*TS %*
Douglas Fir	8,200	31
Blackcap Raspberry	5,800	22
Thimbleberry	3,400	13
Ceanothus	2,600	10
Falsebox	1,400	5
Trailing Blackberry	1,200	5
Black Cottonwood	1,000	4
High Brush Cranberry	600	2
Red Raspberry	600	2
Western Red Cedar	600	2
Douglas Spirea	400	2
Paper Birch	400	2
Summary:	***26,200***	***100***

Veg / Brush	*% Cover*	*Avg Ht. (cm)*	*Avg % Cover*	*Avg Ht. (cm)*
Herb 1	40	20	33	34
Herb 2	45	20		
Shrub 1	40	50		
Shrub 2	40	70		
Tree 1	1	10		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

247.1/249.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 247.1/249.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Thimbleberry	13,000	33
Falsebox	10,800	28
Red Raspberry	5,600	14
Blackcap Raspberry	4,600	12
Ceanothus	2,000	5
Douglas Fir	2,000	5
Bigleaf Maple	600	2
High Brush Cranberry	400	1
Birch leaf Spirea	200	1
Summary:	***39,200***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	50	45	64	50
Herb 2	50	30		
Shrub 1	90	60		
Shrub 2	65	65		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	**Date**	

Transmission Line Surveys

250.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 250.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 5

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Douglas Fir	16,800	55
Thimbleberry	5,000	16
Black Cottonwood	3,600	12
Falsebox	2,600	8
Ceanothus	1,200	4
Blackcap Raspberry	1,000	3
High Brush Cranberry	200	1
Prince's Pine	200	1
Western Red Cedar	200	1
Summary:	***30,800***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	8	30	8.5	40.0
Herb 2	9	50		

Qualified Forest Professional's Statement	
Declaration	
Forest Professional	**Date**

Affix Professional Seal Here

Transmission Line Surveys

255.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 255.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 6

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Thimbleberry	8,600	24
Douglas Fir	8,000	23
Falsebox	5,400	15
Red Raspberry	3,400	10
Blackcap Raspberry	3,000	9
Trailing Blackberry	2,600	7
Western Red Cedar	1,200	3
Black Cottonwood	800	2
Ceanothus	600	2
Salmonberry	600	2
Willow	400	1
Paper Birch	200	1
Highbrush Cranberry	200	1
Western Hemlock	200	1
Summary:	***35,200***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	20	20	10	25
Herb 2	21	35		
Shrub 1	9	40		
Shrub 2	8	30		
Tree 1	1	10		
Tree 2	1	15		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Transmission Line Surveys

260.1 Road

Project Information

Project: Longterm Revegetation Monitoring
Site: 260.1 Road
Location: Upper Lillooet Hydro Project
Mapsheet: Map 6

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Sep 18, 2020
Field Finish: Oct 19, 2020
# of plots: 1

Inventory Information

Species	TS (SPH)	TS %
Thimbleberry	8,400	74
Blackcap Raspberry	1,800	16
Bigleaf Maple	600	5
Saskatoon	400	4
Sitka Alder	200	2
Summary:	***11,400***	***100***

Veg / Brush	% Cover	Avg Ht. (cm)	Avg % Cover	Avg Ht. (cm)
Herb 1	55	40	37	51
Herb 2	70	50		
Shrub 1	5	50		
Shrub 2	17	65		

Qualified Forest Professional's Statement		Affix Professional Seal Here
Declaration		
Forest Professional	Date	

Transmission Line Surveys

Ryan Crossing

Project Information

Project: Longterm Revegetation Monitoring
Site: Ryan Crossing
Location: Upper Lillooet Hydro Project
Mapsheet: Map 6

Contractor: Hedberg Associates
Surveyor(s): C. Johnston
Field Start: Jul 15, 2020
Field Finish: Oct 20, 2020
# of plots: 1

Inventory Information

Species	***TS (SPH)***	***TS %***
Thimbleberry	7,400	79
Western Red Cedar	1,000	11
Blackcap Raspberry	600	6
Red Osier Dogwood	400	4
Summary:	***9,400***	***100***

Veg / Brush	***% Cover***	***Avg Ht. (cm)***	***Avg % Cover***	***Avg Ht. (cm)***
Herb 1	12	25	13	31
Herb 2	11	20		
Shrub 1	13	40		
Shrub 2	16	40		

Qualified Forest Professional's Statement		*Affix Professional Seal Here*
Declaration		
Forest Professional	**Date**	

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
53.1/56.1	31	Sep 18, 2020 13:23	5604651	476007	Black Cottonwood	15	Herb 1	90	70
					Red Osier Dogwood	1	Herb 2	68	20
					Red Raspberry	4	Tree 2	3	40
					Thimbleberry	11			
					Willow	1			
						32			
						32			
73.1	30	Sep 18, 2020 13:47	5604016	477759	Black Cottonwood	29	Herb 1	3	10
					Douglas Fir	2	Herb 2	16	80
					Falsebox	6	Shrub 1	8	50
					Red Raspberry	50	Shrub 2	7	45
					Thimbleberry	80	Tree 1	1	17
					Willow	2			
						169			
						169			
129.1	29	Oct 19, 2020 14:07	5600841	486288	Black Cottonwood	2	Herb 1	60	15
					Ceanothus	1	Herb 2	6	35
					Falsebox	5			
					Kinnickinick	4			
					Lodgepole Pine	8			
						20			
						20			
130.1	28	Oct 19, 2020 13:50	5600806	486419	Black Cottonwood	2	Herb 1	22	15
					Blackcap Raspberry	1	Herb 2	80	20
					Douglas Fir	3			
					Falsebox	7			
					Kinnickinick	10			
					Lodgepole Pine	16			
					Willow	2			
						41			
						41			
133.1	27	Oct 19, 2020 13:29	5600673	486898	Bitter Cherry	1	Herb 1	100	25
					Black Cottonwood	1	Herb 2	65	20
					Douglas Fir	2			
					Falsebox	1			
					Lodgepole Pine	4			
					Red Raspberry	2			
						11			
						11			

HEDBERG ASSOCIATES NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
140.1	35	Oct 19, 2020 11:06	5599221	487568	Black Cottonwood	31	Tree 1	100	270
					Paper Birch	2	Tree 2	100	250
					Red Alder	139			
					Red Osier Dogwood	1			
					Red Raspberry	1			
					Thimbleberry	8			
					Western Red Cedar	10			
					Willow	1			
						193			
						193			
163.1	35A	Oct 19, 2020 11:54	5597276	491657	Douglas Fir	5	Herb 1	19	14
					Falsebox	3	Herb 2	25	10
					Gooseberry	1	Shrub 1	12	40
					Pacific Dogwood	2	Shrub 2	21	35
					Paper Birch	15			
					Red Osier Dogwood	1			
					Red Raspberry	92			
					Saskatoon	1			
					Thimbleberry	27			
						147			
						147			
237.1	34	Sep 18, 2020 06:30	5590785	500653	Bigleaf Maple	1	Herb 1	5	15
					Black Cottonwood	54	Herb 2	65	60
					Douglas Fir	44	Shrub 1	55	45
					Falsebox	3	Shrub 2	4	50
					High Brush Cranberry	2	Tree 1	1	35
					Red Alder	2	Tree 2	3	100
					Thimbleberry	70			
					Willow	8			
						184			
						184			
238.1	33	Sep 18, 2020 07:46	5590639	500853	Black Cottonwood	1	Herb 1	35	25
					Blackcap Raspberry	4	Herb 2	80	35
					Ceanothus	10	Shrub 1	5	25
					Douglas Fir	70	Shrub 2	3	25
					Douglas Spirea	2	Tree 1	1	9
					Falsebox	26	Tree 2	1	10
					Thimbleberry	24			
						137			
						137			

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
239.1	32	Sep 18, 2020 06:27	5590571	501029	Black Cottonwood	2	Herb 1	85	40
					Thimbleberry	2	Herb 2	85	40
						4			
						4			
245.1	26	Sep 18, 2020 06:32	5589865	501981	Black Cottonwood	5	Herb 1	40	20
					Blackcap Raspberry	29	Herb 2	45	20
					Ceanothus	13	Shrub 1	40	50
					Douglas Fir	41	Shrub 2	40	70
					Douglas Spirea	2	Tree 1	1	10
					Falsebox	7			
					High Brush Cranberry	3			
					Paper Birch	2			
					Red Raspberry	3			
					Thimbleberry	17			
					Trailing Blackberry	6			
					Western Red Cedar	3			
						131			
						131			
247.1/249.1	25	Sep 18, 2020 06:38	5589674	502321	Bigleaf Maple	3	Herb 1	50	45
					Blackcap Raspberry	23	Herb 2	50	30
					Ceanothus	10	Shrub 1	90	60
					Douglas Fir	10	Shrub 2	65	65
					Douglas Spirea	1			
					Falsebox	54			
					High Brush Cranberry	2			
					Red Raspberry	28			
					Thimbleberry	65			
						196			
						196			
250.1	24	Oct 9, 2020 12:16	5589558	502458	Black Cottonwood	18	Herb 1	8	30
					Blackcap Raspberry	5	Herb 2	9	50
					Ceanothus	6			
					Douglas Fir	84			
					Falsebox	13			
					High Brush Cranberry	1			
					Prince's Pine	1			
					Thimbleberry	25			
					Western Red Cedar	1			
						154			
						154			

HEDBERG ASSOCIATES
NATURAL RESOURCE MANAGEMENT

INNERGEX

Project: Longterm Revegetation Monitoring 2020 (Year 3)

Civl Work Sites (Plots established in 2018)

Stratum	Plot No.	Timestamp/Date	UTM N	UTM E	Spp	TS	Percent Cover of Quadrant Plots: Species	% Cover	Height (cm)
255.1	23	Sep 18, 2020 07:25	5588767	503270	Black Cottonwood	4	Herb 1	20	20
					Blackcap Raspberry	15	Herb 2	21	35
					Ceanothus	3	Shrub 1	9	40
					Douglas Fir	40	Shrub 2	8	30
					Falsebox	27	Tree 1	1	10
					Paper Birch	1	Tree 2	1	15
					Red Raspberry	17			
					Highbrush Cranberry	1			
					Salmonberry	3			
					Thimbleberry	43			
					Trailing Blackberry	13			
					Western Hemlock	1			
					Western Red Cedar	6			
					Willow	2			
						176			
						176			
260.1	21	Sep 18, 2020 07:31	5587958	503833	Bigleaf Maple	3	Herb 1	55	40
					Blackcap Raspberry	9	Herb 2	70	50
					Saskatoon	2	Shrub 1	5	50
					Sitka Alder	1	Shrub 2	17	65
					Thimbleberry	42			
						57			
						57			
Ryan Crossing	22	Sep 18, 2020 07:28	5587958	504319	Blackcap Raspberry	3	Herb 1	12	25
					Red Osier Dogwood	2	Herb 2	11	20
					Thimbleberry	37	Shrub 1	13	40
					Western Red Cedar	5	Shrub 2	16	40
						47			
						47			
						1699			

Appendix C. Representative Water Temperature and Air Temperature Site Photographs, 2020

LIST OF FIGURES

Figure 1. Looking upstream at ULL-USWQ03 on October 22, 2020.

Figure 2. Looking downstream at ULL-USWQ03 on October 22, 2020.

Figure 3. Looking at ULL-USAT02 on October 22, 2020.

Figure 4. Looking at ULL-USAT02 on October 22, 2020.

Figure 5. Looking upstream at ULL-DVWQ01 on October 22, 2020.

Figure 6. Looking at the Tidbit location at ULL-DVWQ01 on October 22, 2020.

Figure 7. Looking upstream at ULL-TAILWQ on May 12, 2020.

Figure 8. Looking RR to RL at ULL-TAILWQ on May 12, 2020.

Figure 9. Looking at RR-RL at ULL-TAILWQ on October 22, 2020.

Figure 10. Looking upstream at ULL-TAILWQ on October 22, 2020.

Figure 11. Looking upstream at ULL-DSWQ on May 12, 2020.

Figure 12. Looking downstream at ULL-DSWQ on May 12, 2020.

Figure 13. Looking upstream at ULL-DSWQ on October 22, 2020.

Figure 14. Looking downstream at ULL-DSWQ on October 22, 2020.

Figure 15. Looking at ULL-DSAT on May 12, 2020.

Figure 16. Looking at ULL-DSAT on October 2, 2020.

1. BOULDER CREEK

Figure 17. Looking upstream at BDR-USWQ2 on October 22, 2020.

Figure 18. Looking downstream at BDR-USWQ2 on October 22, 2020.

Figure 19. Looking upstream at NTH-USWQ1 on October 22, 2020.

Figure 20. Looking downstream at NTH-USWQ1 on October 22, 2020.

Figure 21. Looking upstream at BDR-DVWQ on May 12, 2020.

Figure 22. Looking downstream at BDR-DVWQ on May 12, 2020.

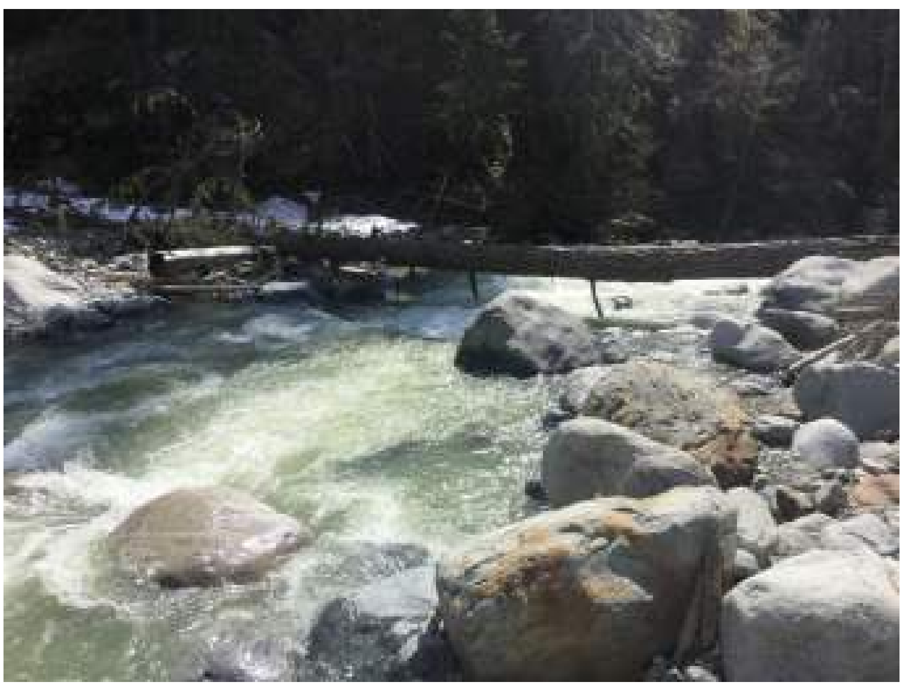


Figure 23. Looking at Tidbit location at BDR-DVWQ on October 01, 2020.

Figure 24. Looking upstream at BDR-TAILWQ on May 12, 2020.

Figure 25. Looking downstream at BDR-TAILWQ on May 12, 2020.

Figure 26. Looking upstream at BDR-TAILWQ on October 22, 2020.

Figure 27. Looking downstream at BDR-TAILWQ on October 22, 2020.

Figure 28. Looking upstream at Tidbit 1 at BDR-DSWQ on May 12, 2020.

Figure 29. Looking downstream at Tidbit 1 at BDR-DSWQ on May 12, 2020.

Figure 30. Looking upstream at Tidbit 1 at BDR-DSWQ on October 22, 2020.

Figure 31. Looking upstream at Tidbit 2 at BDR-DSWQ on October 22, 2020.

Appendix D. Water Temperature Guidelines and Data Summary

LIST OF FIGURES

LIST OF TABLES

1. WATER TEMPERATURE GUIDELINES

Table 1. Water temperature guidelines for the protection of freshwater aquatic life (Oliver and Fidler 2001, MOE 2019).

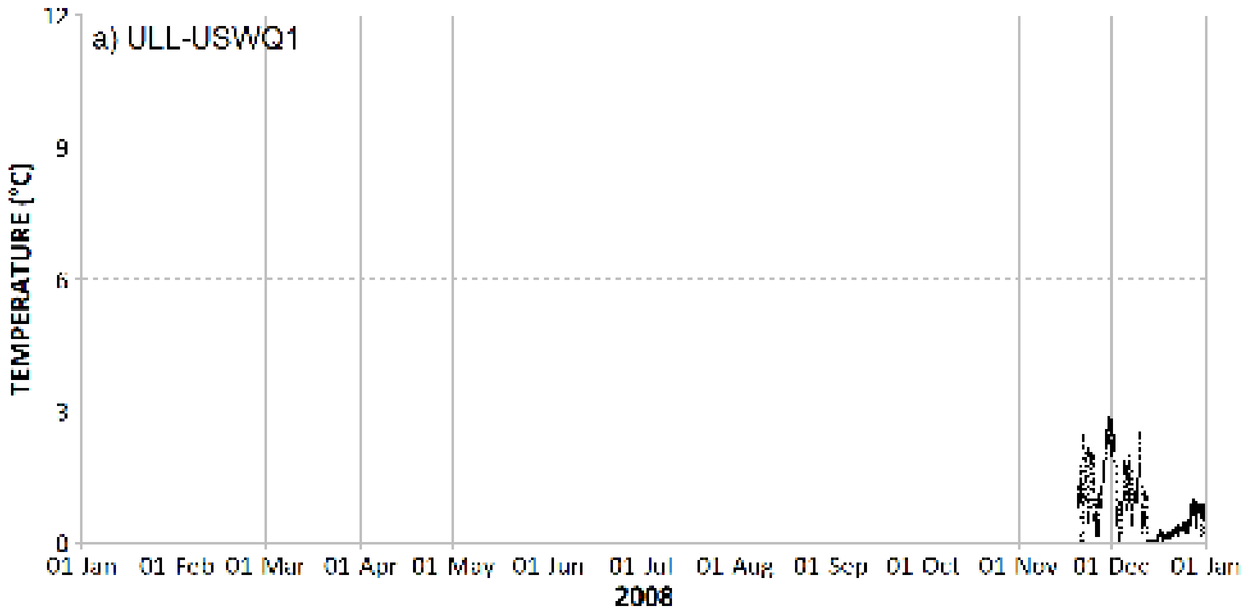
Category	Guideline[1]
All Streams	the rate of temperature change in natural water bodies not to exceed 1°C/hr
	temperature metrics to be described by the mean weekly maximum temperature (MWMxT)
Streams with Known Fish Presence	mean weekly maximum water temperatures should not exceed ±1°C beyond the optimum temperature range for each life history phase of the most sensitive salmonid species present[1]
Streams with Bull Trout or Dolly Varden	maximum daily temperature is 15°C
	maximum incubation temperature is 10°C
	minimum incubation temperature is 2°C
	maximum spawning temperature is 10°C
Streams with Unknown Fish Presence	salmonid rearing temperatures not to exceed MWMxT of 18°C
	maximum daily temperature not to exceed 19°C
	maximum temperature for salmonid incubation from June until August not to exceed 12°C

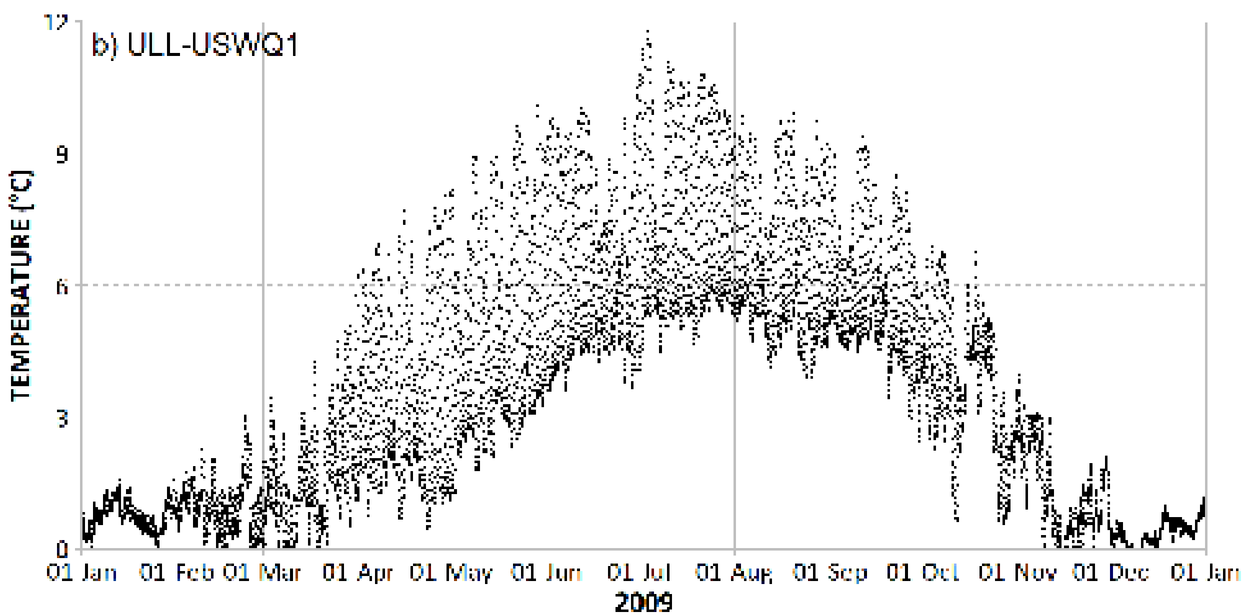
[1] The guidelines state that "the natural temperature cycle characteristic of the site should not be altered in amplitude or frequency by human activities". Accordingly, it is implied that when conditions are naturally outside of guidelines, human activities should not increase the magnitude and/or frequency to which conditions are outside of guidelines.

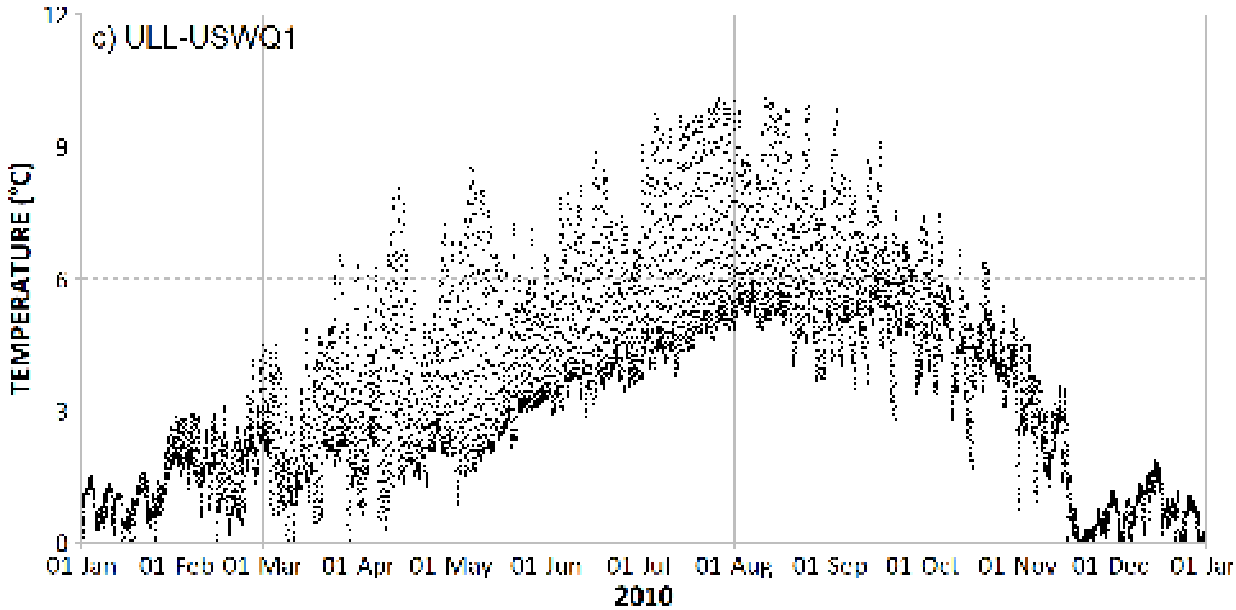
2. WATER TEMPERATURE DATA

2.1. Upper Lillooet River

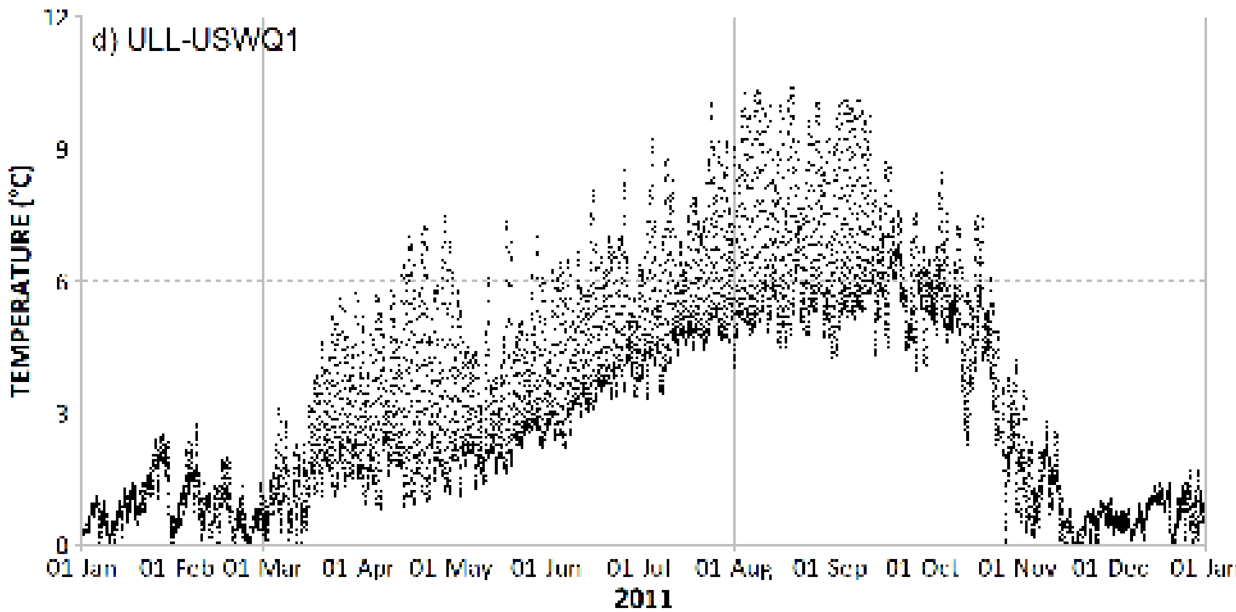
Figure 1. Baseline water temperature at ULL-USWQ1 from 2008 to 2013. Black dots show water temperature at intervals of 15 minutes.



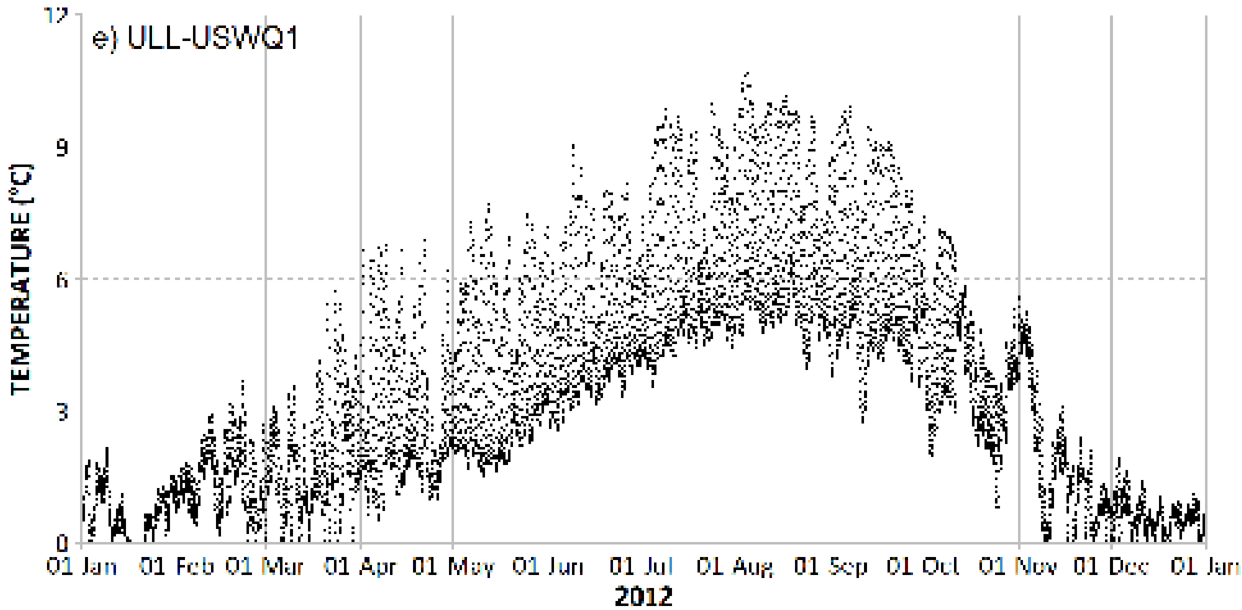




c) ULL-USWQ1
TEMPERATURE (°C)
0
3
6
9
12
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2010



d) ULL-USWQ1
TEMPERATURE (°C)
0
3
6
9
12
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2011


e) ULL-USWQ1
TEMPERATURE (°C)
12
9
6
3
0
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2012

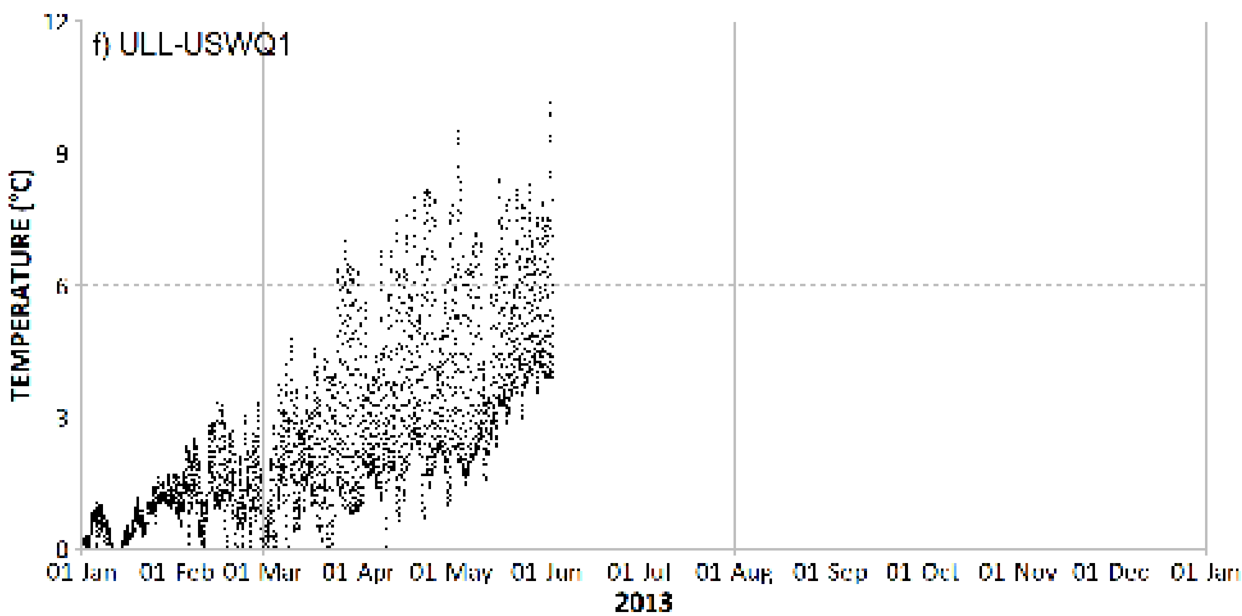

f) ULL-USWQ1
TEMPERATURE (°C)
12
9
6
3
0
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2013

Figure 2. Operational water temperature at ULL-USWQ02 from 2018 to 2019. Black dots show water temperature at intervals of 15 minutes.

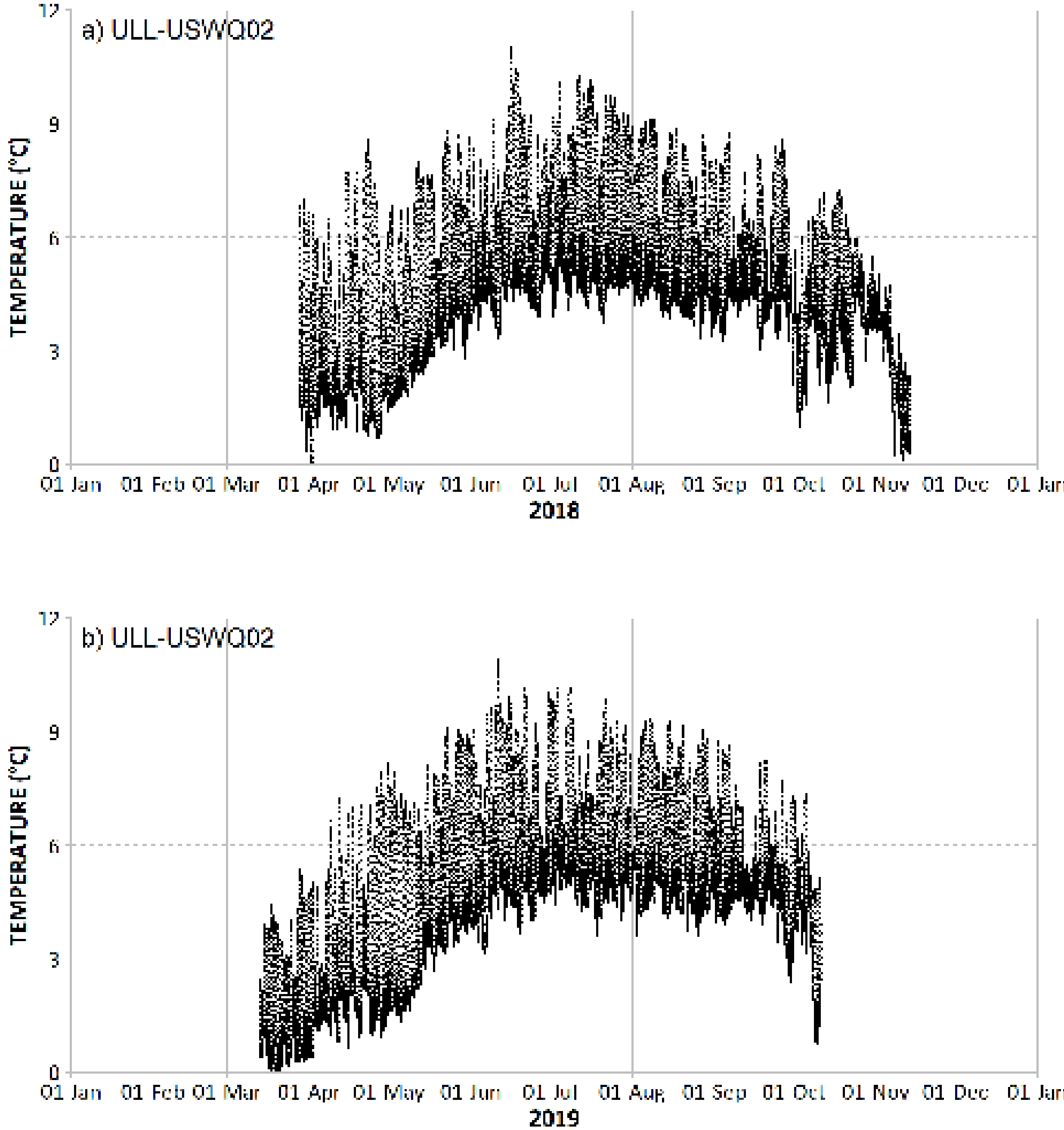
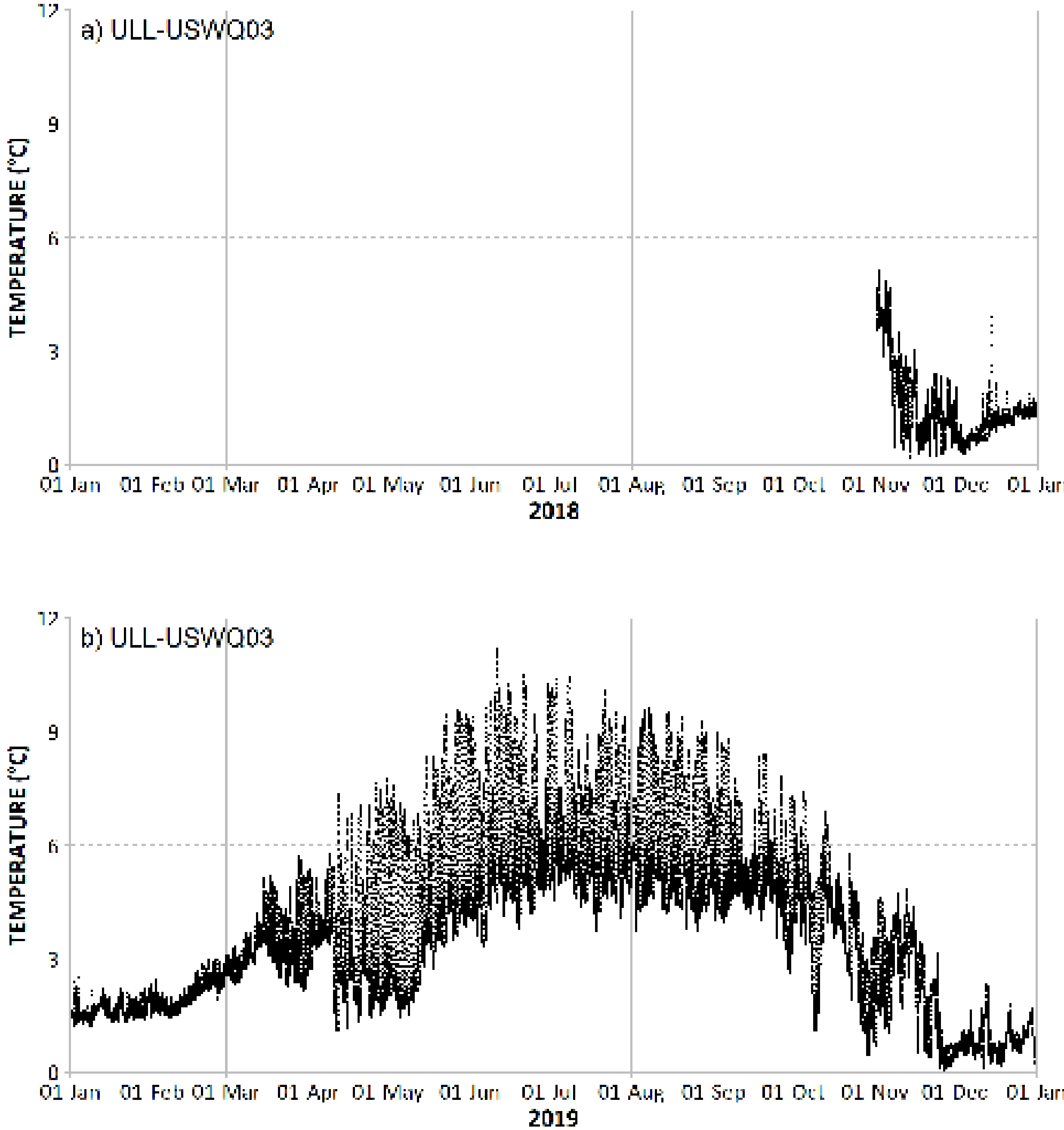


Figure 3. Operational water temperature at ULL-USWQ03 from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.



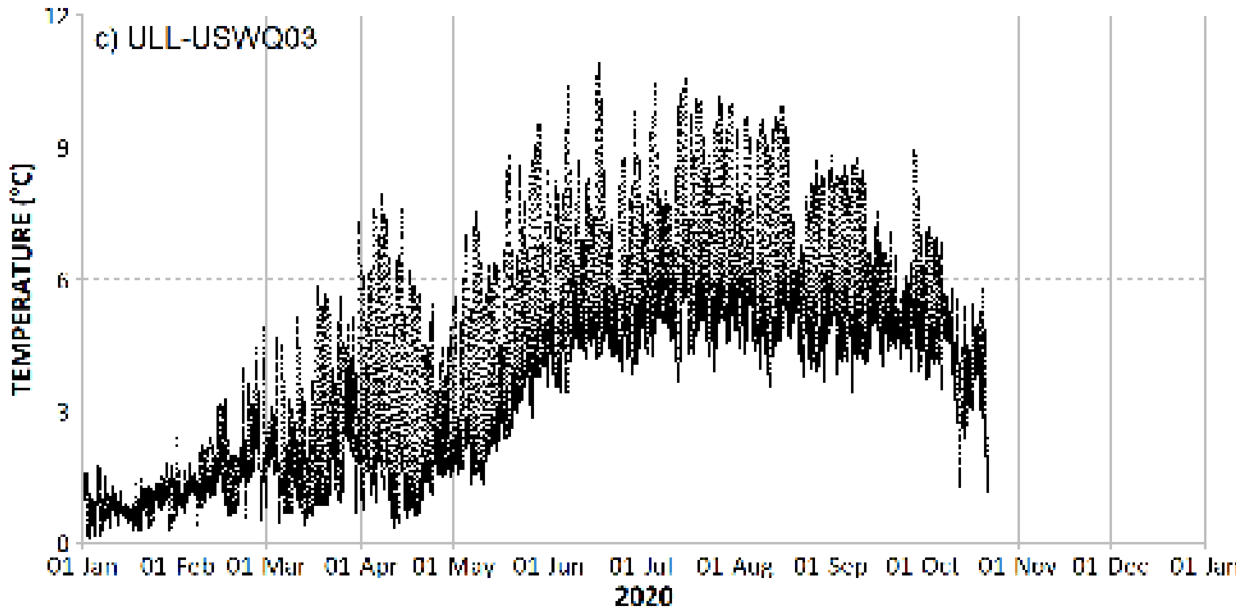
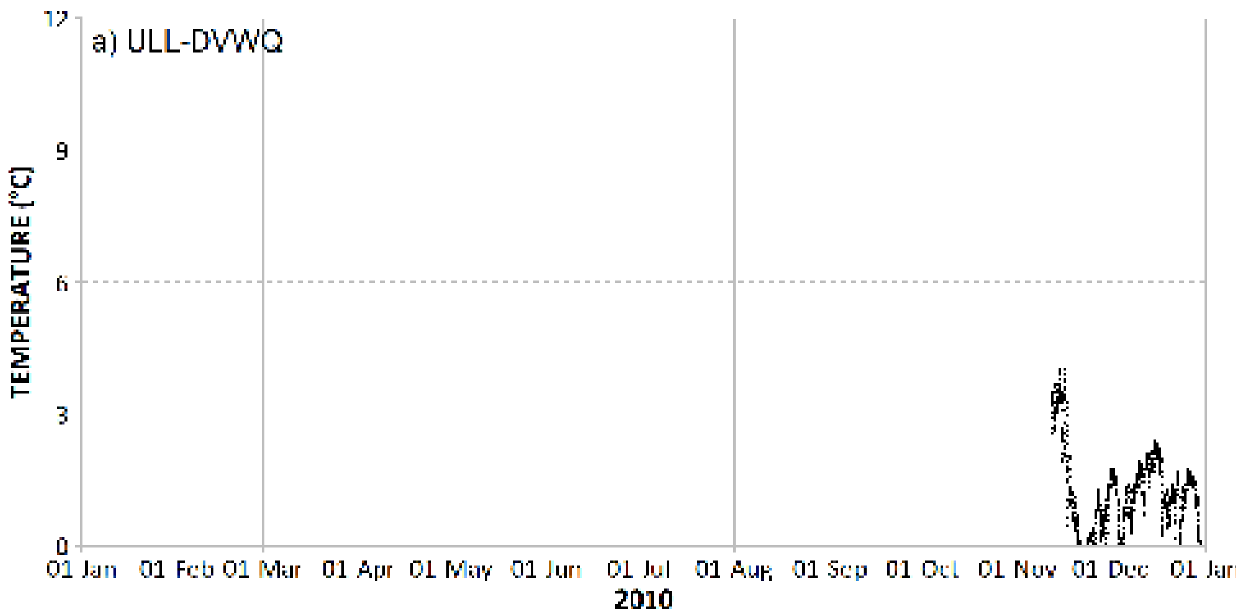
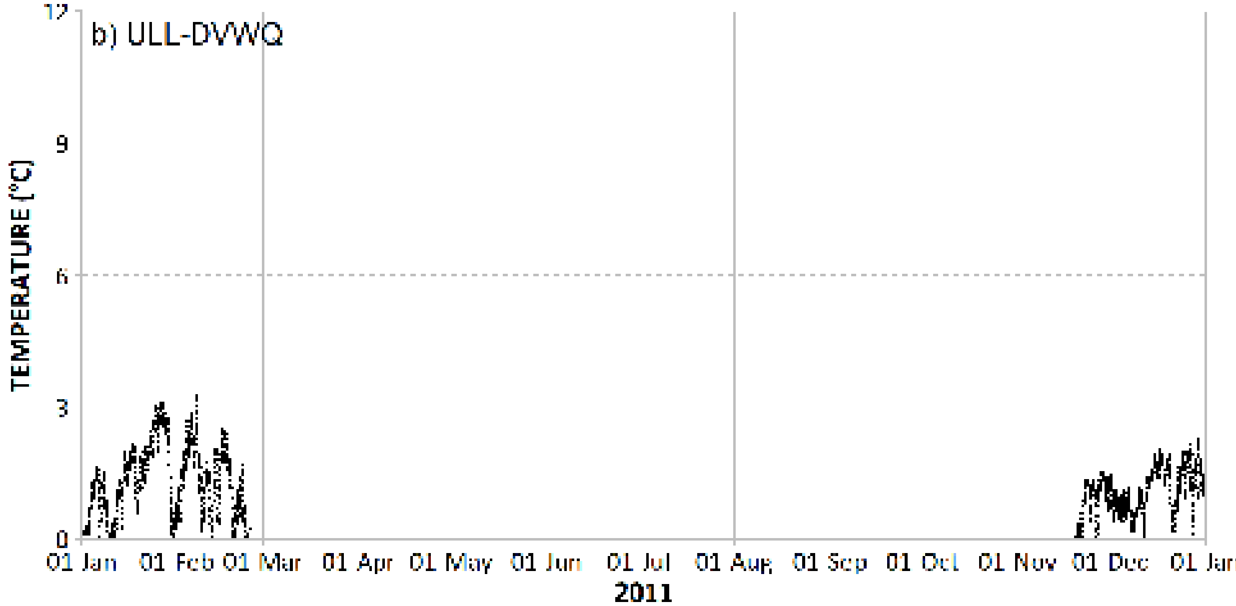
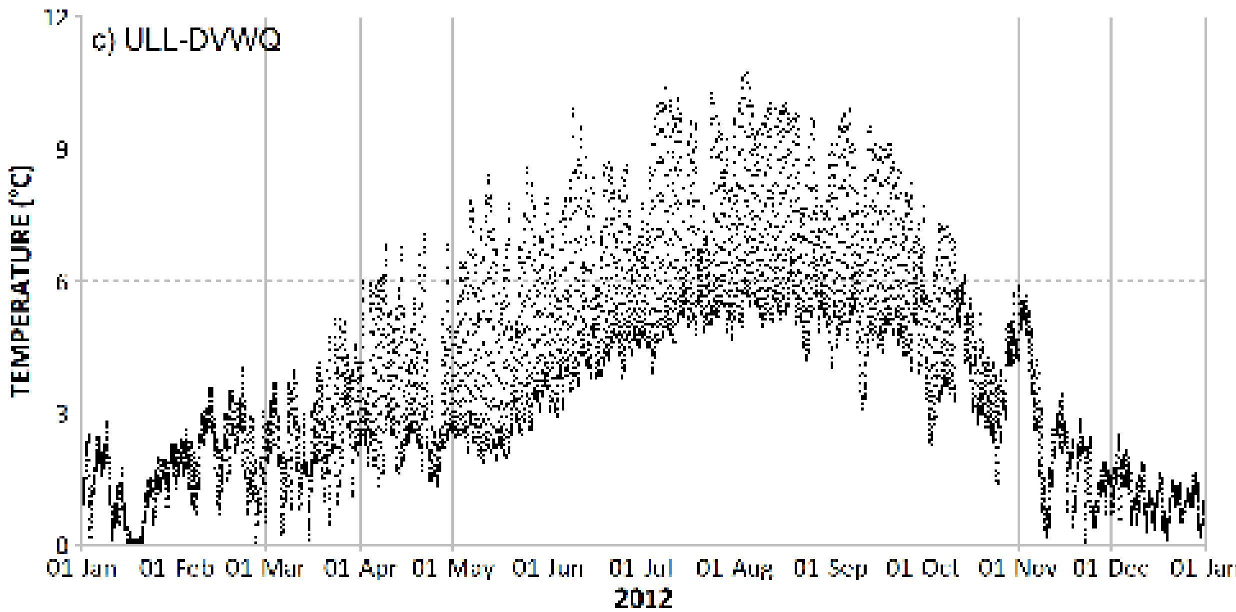


Figure 4. **Baseline water temperature at ULL-DVWQ from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.**




b) ULL-DVWQ
TEMPERATURE (°C)
0
3
6
9
12
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2011


c) ULL-DVWQ
TEMPERATURE (°C)
0
3
6
9
12
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2012

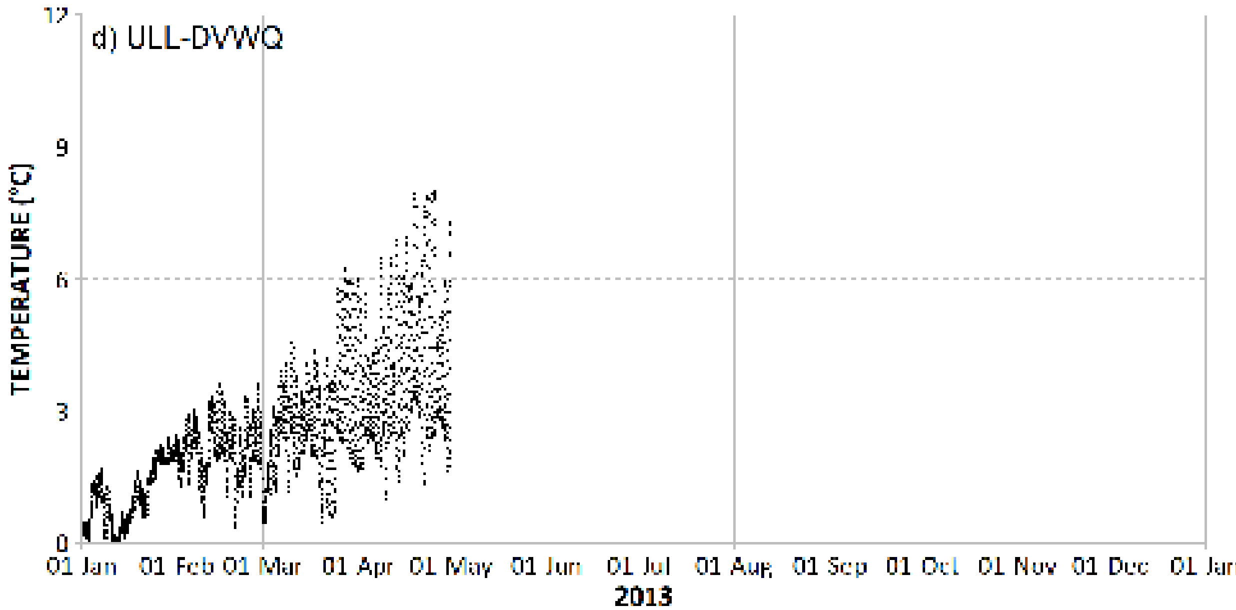
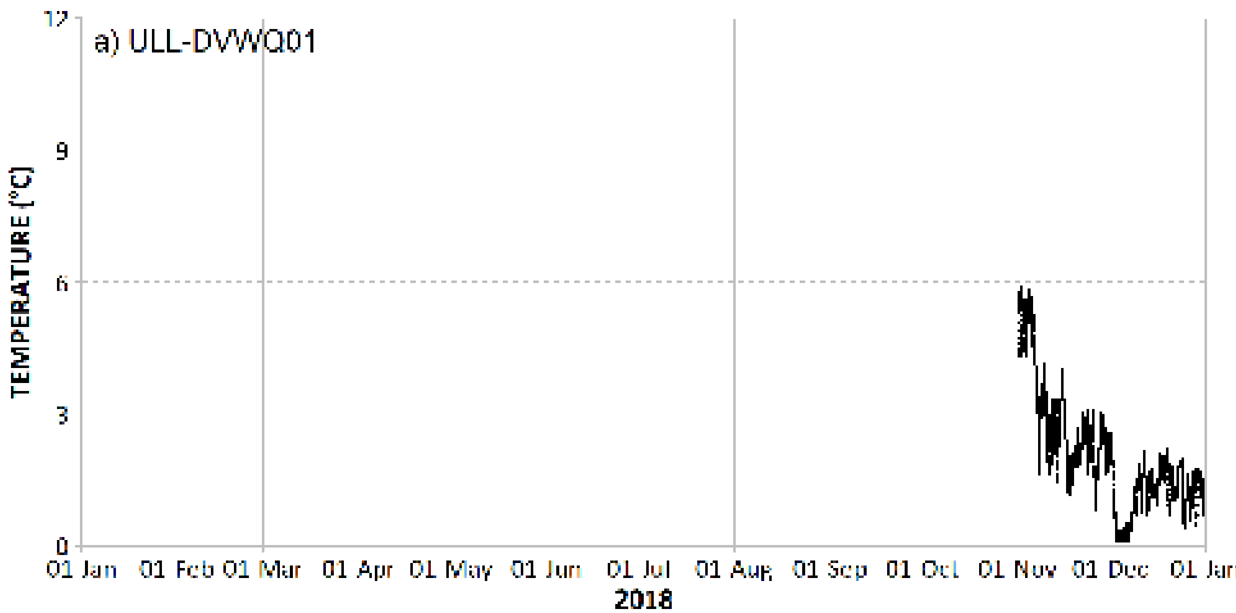
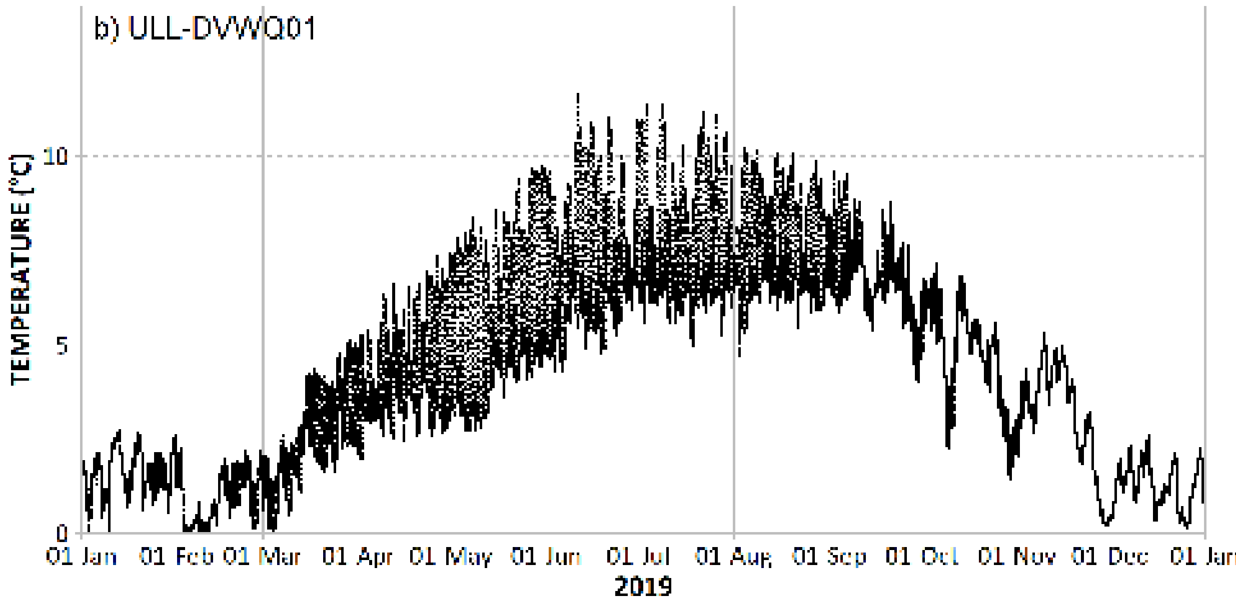


Figure 5. Operational water temperature at ULL-DVWQ01 from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.




b) ULL-DVWQ01
TEMPERATURE (°C)
0
5
10
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2019

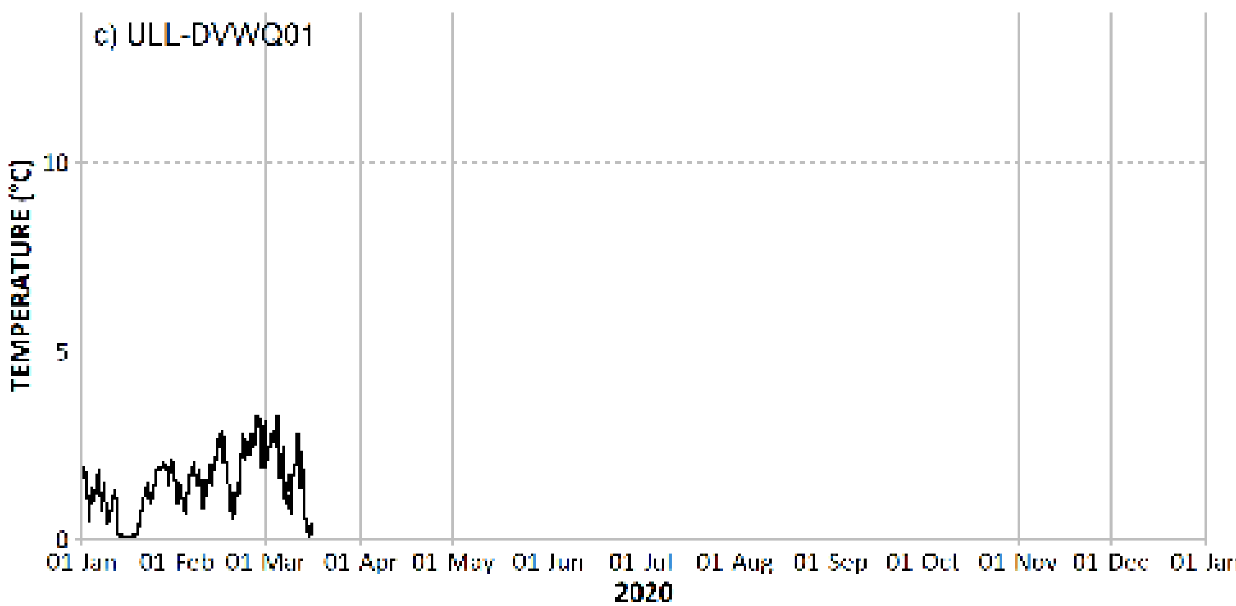
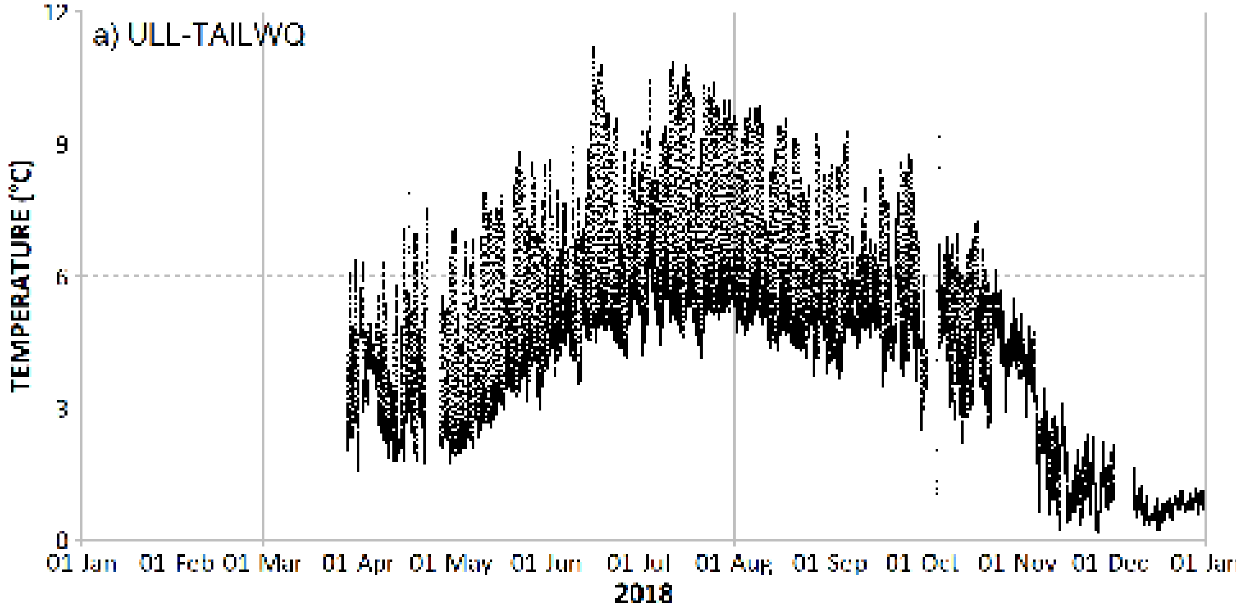
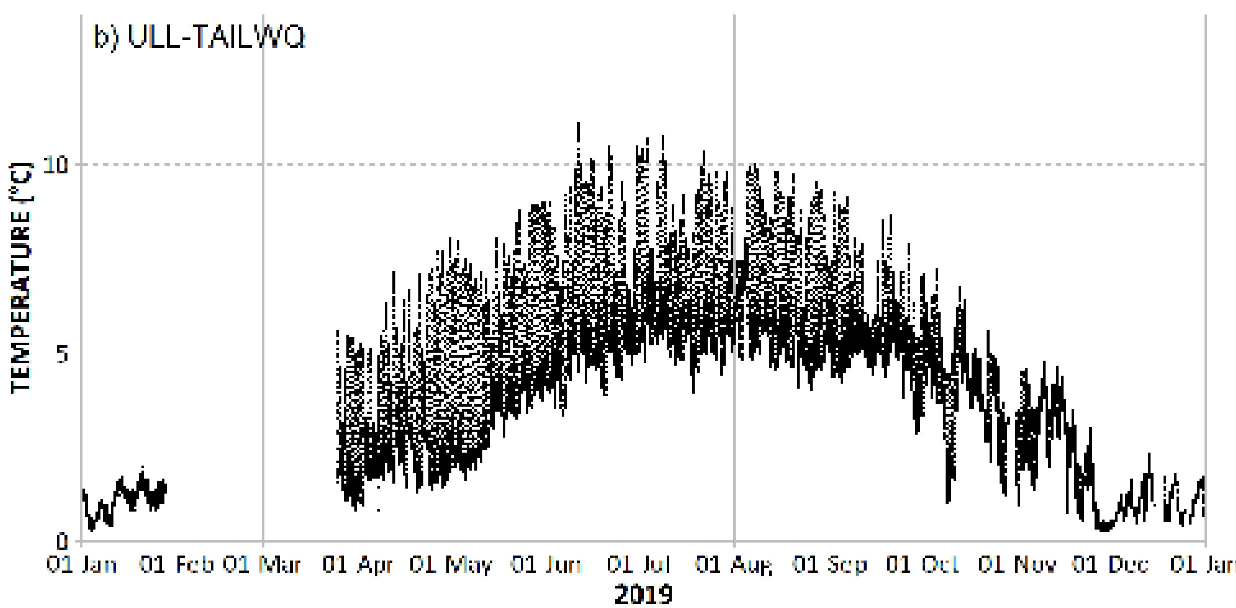

c) ULL-DVWQ01
TEMPERATURE (°C)
0
5
10
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2020

Figure 6. **Operational water temperature at ULL-TAILWQ from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.**





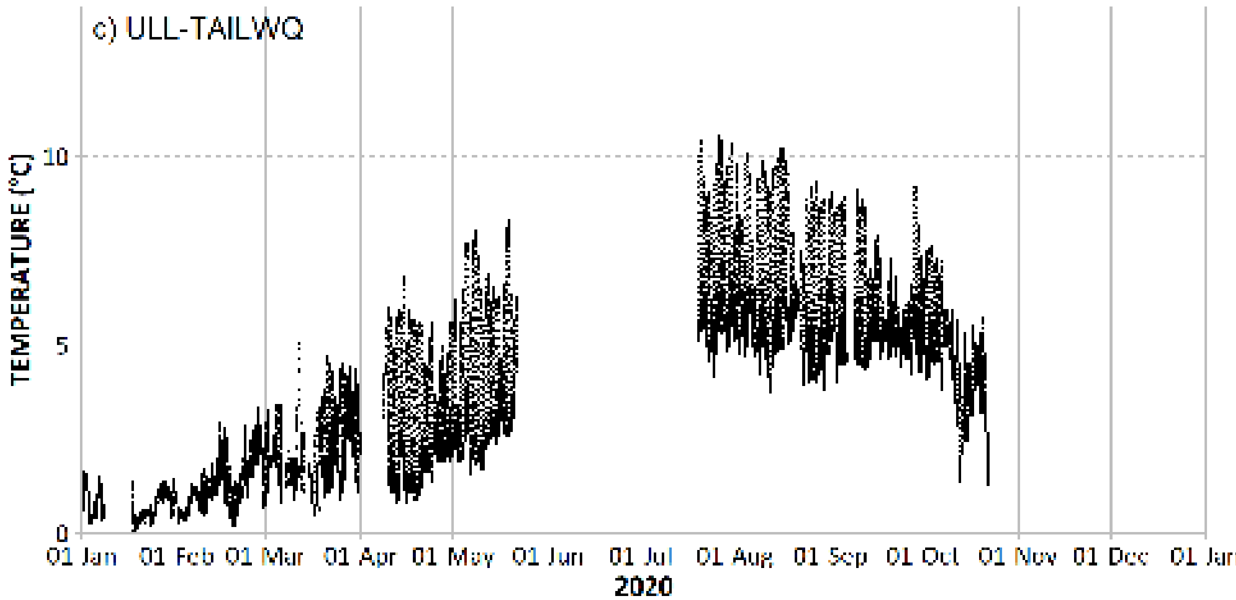
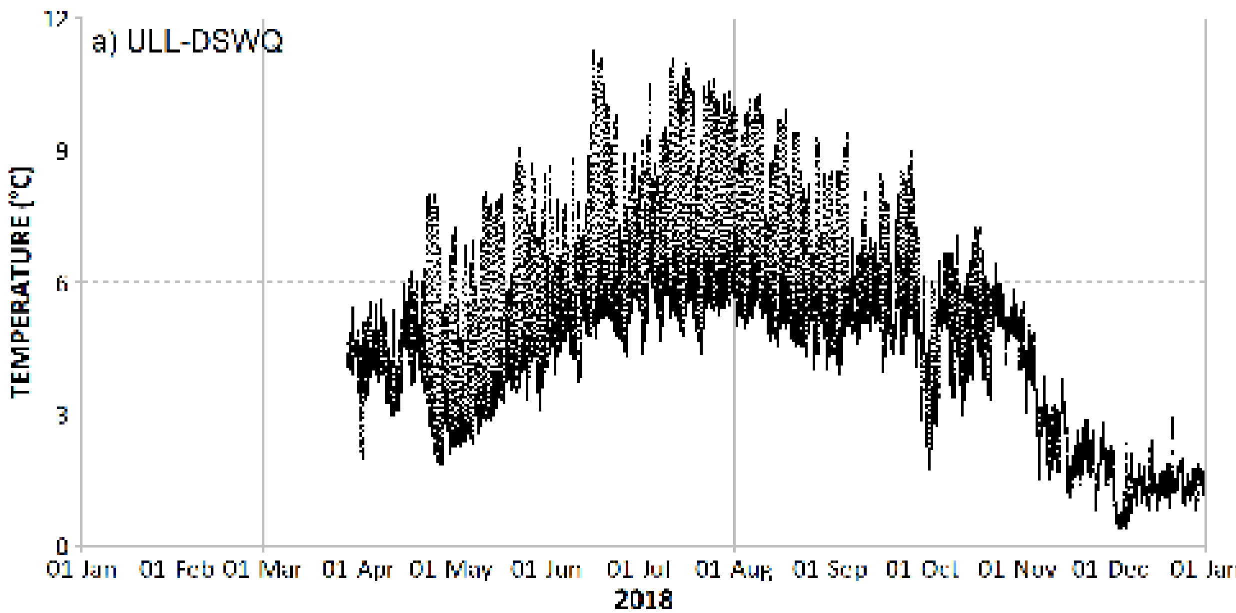
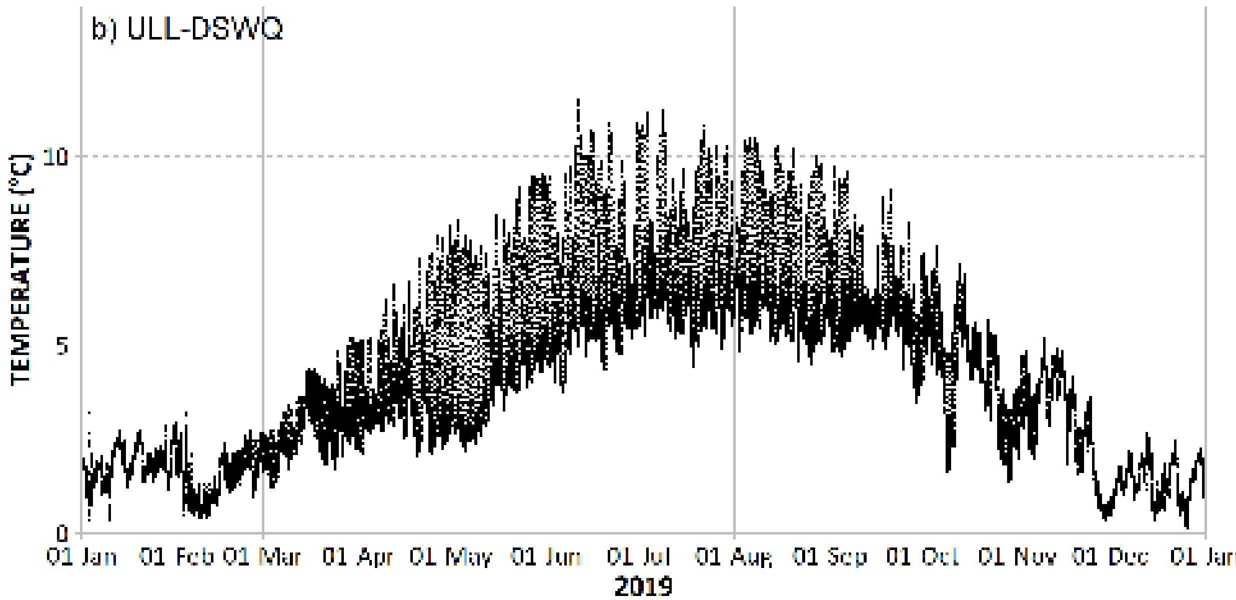
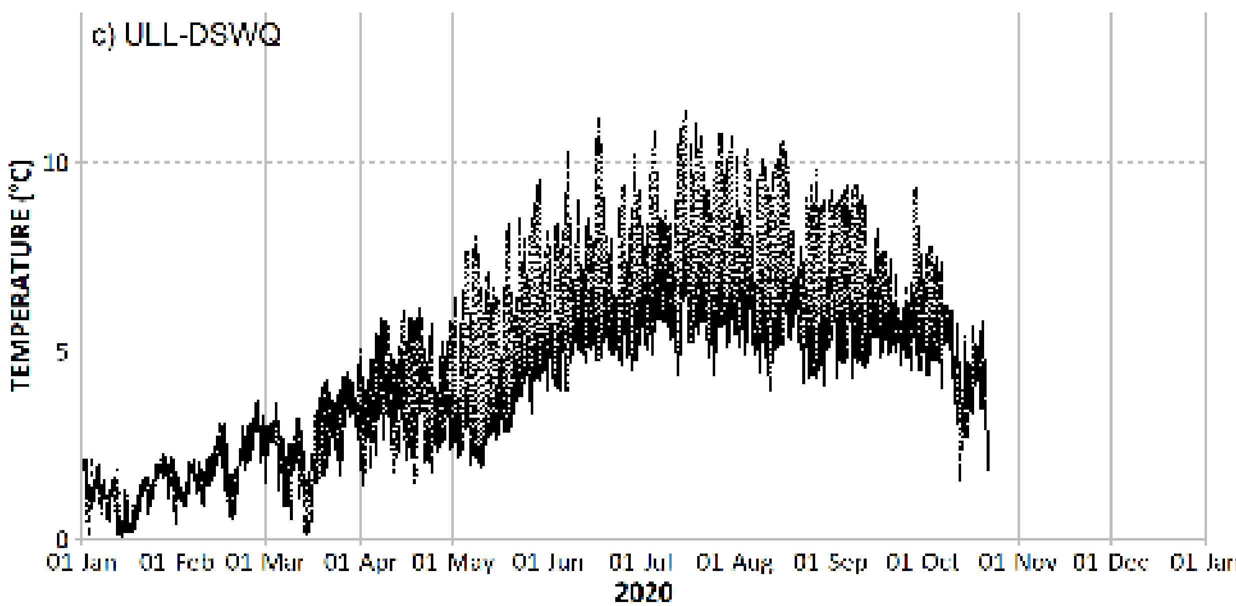


Figure 7. **Operational water temperature at ULL-DSWQ from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.**

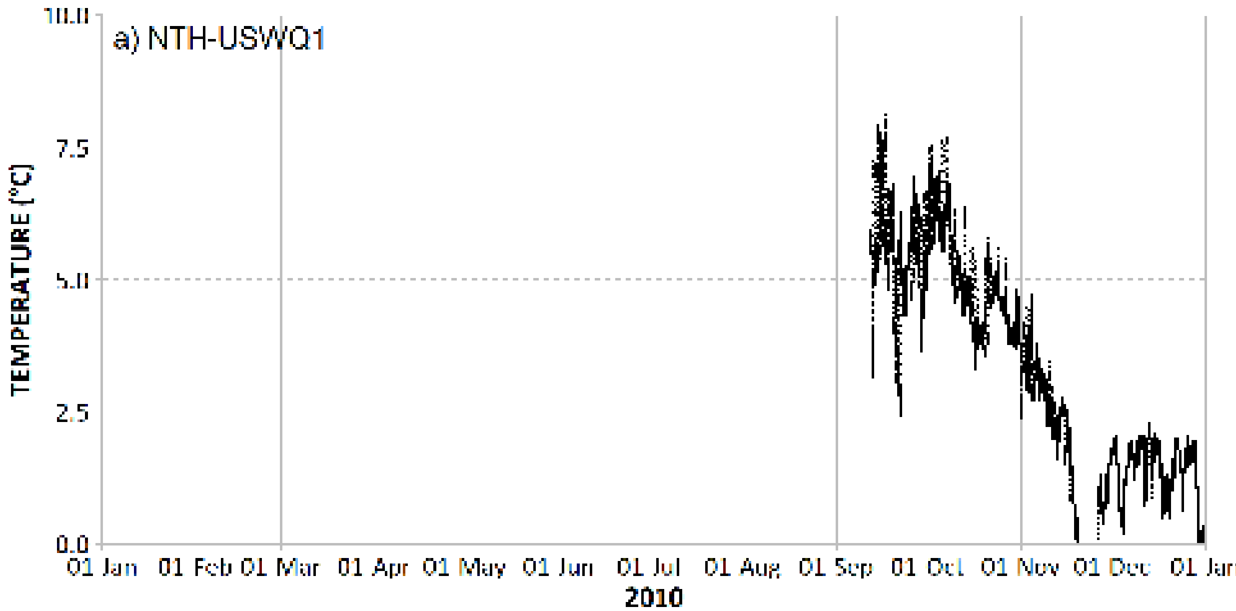


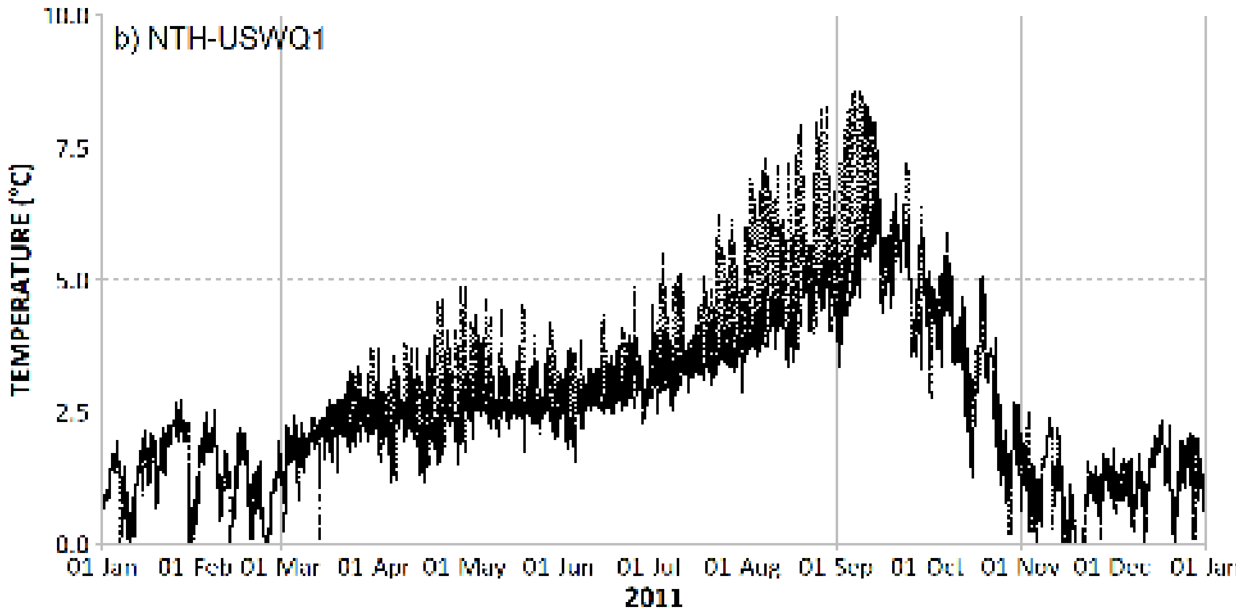

b) ULL-DSWQ
TEMPERATURE (°C)
0
5
10
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2019

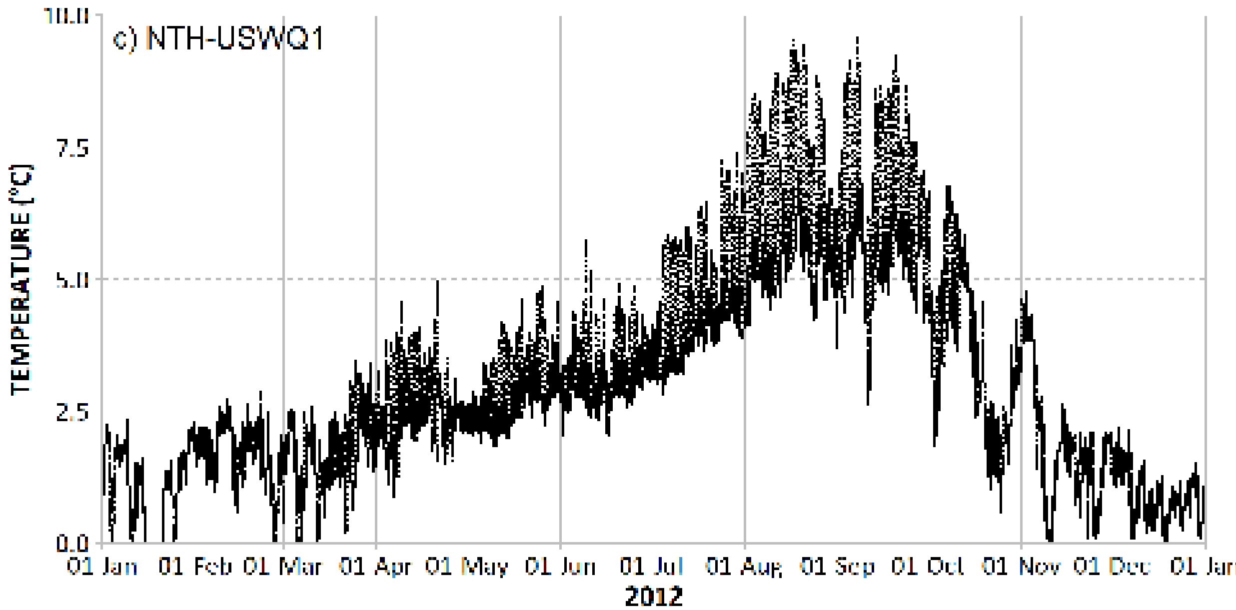

c) ULL-DSWQ
TEMPERATURE (°C)
0
5
10
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2020

2.2. Boulder Creek

Figure 8. Baseline water temperature at NTH-USWQ1 from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.






c) NTH-USWQ1
TEMPERATURE (°C)
10.0
7.5
5.0
2.5
0.0
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2012

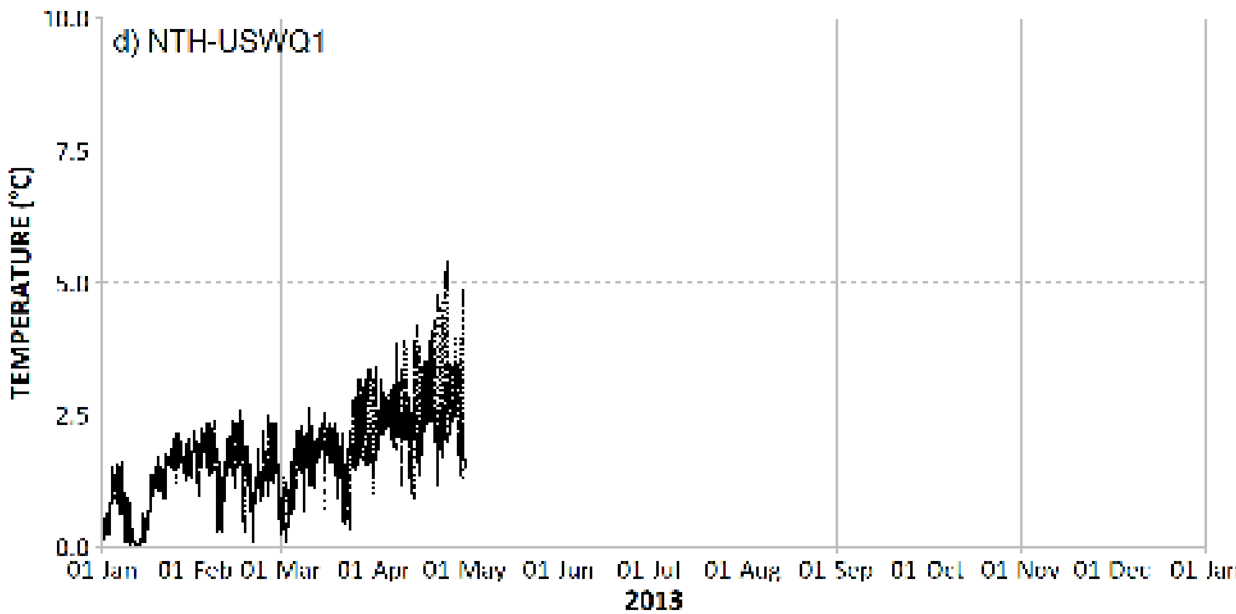
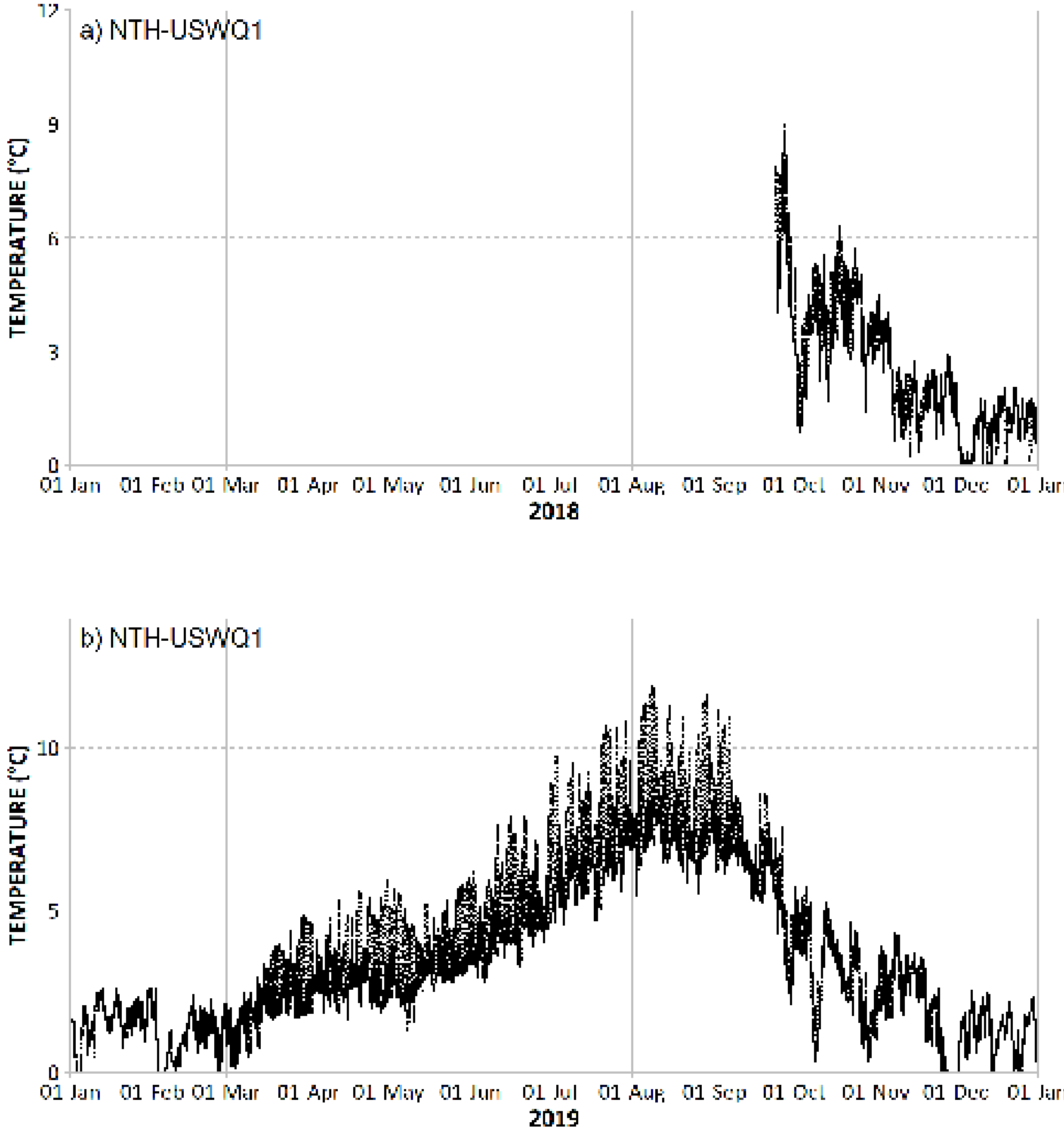

d) NTH-USWQ1
TEMPERATURE (°C)
10.0
7.5
5.0
2.5
0.0
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2013

Figure 9. Operational water temperature at NTH-USWQ1 from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.



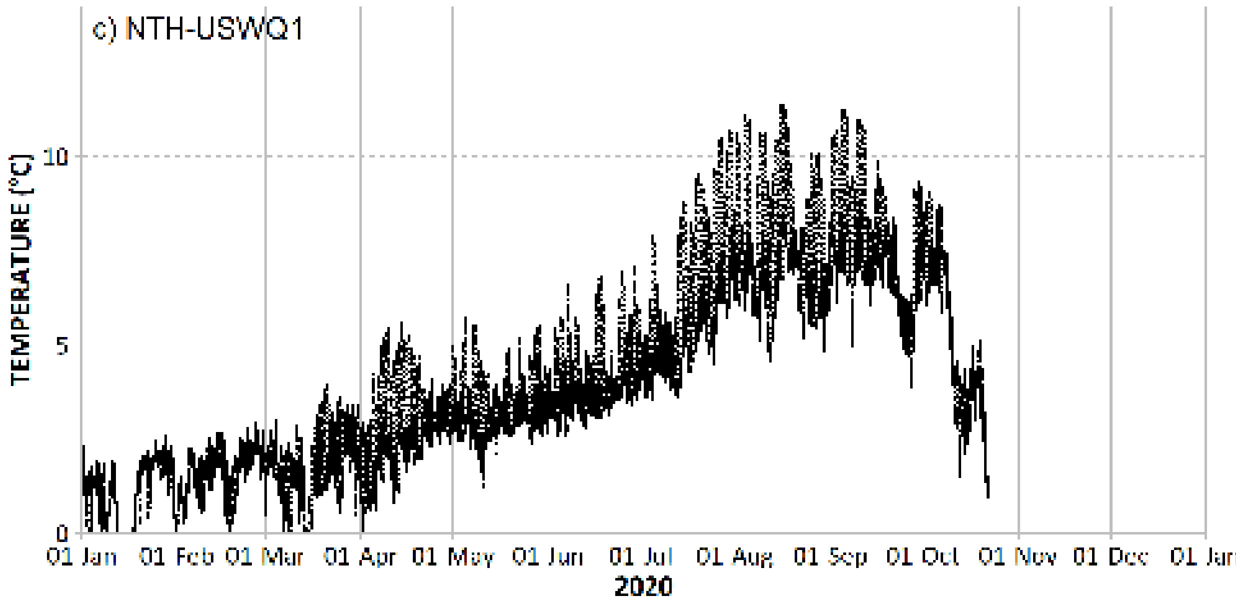
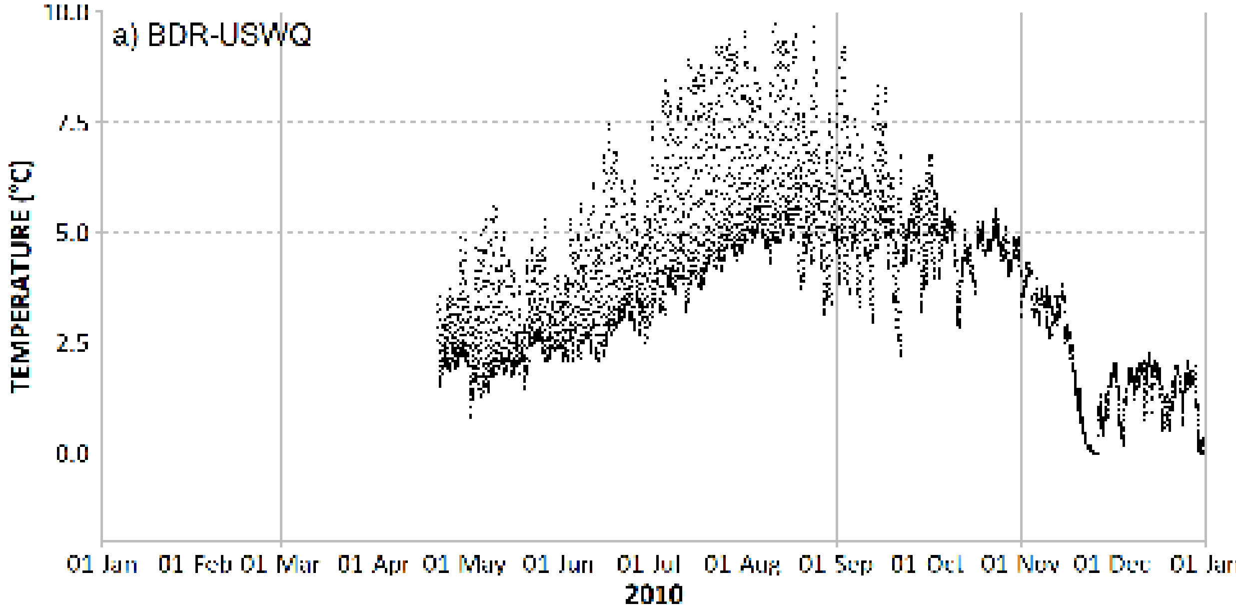
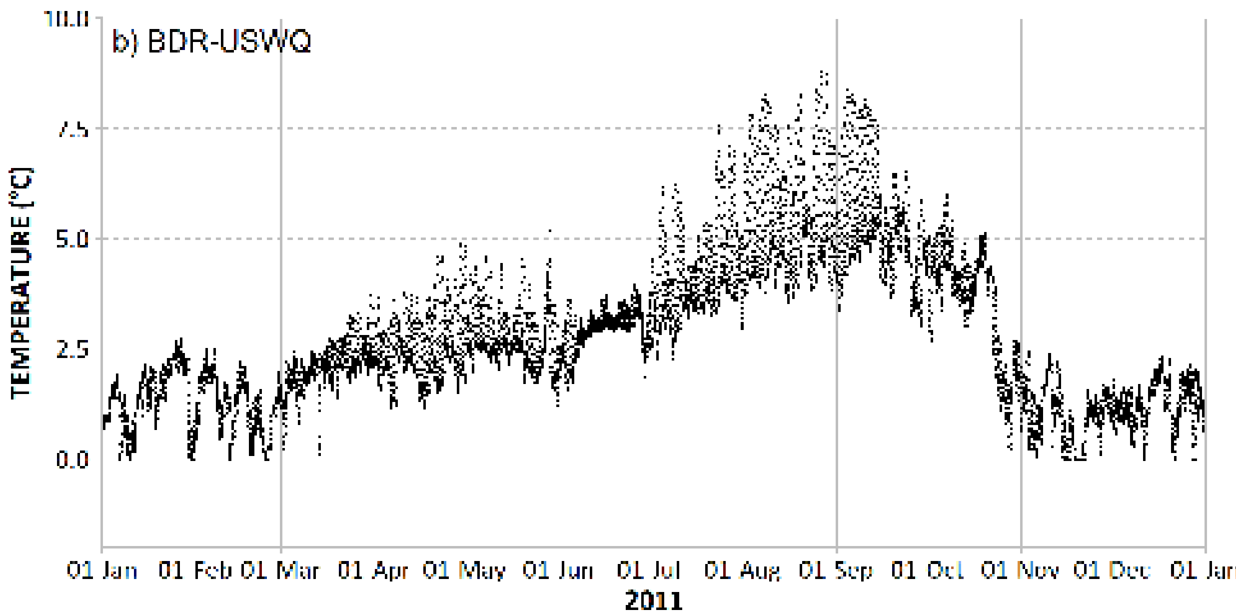
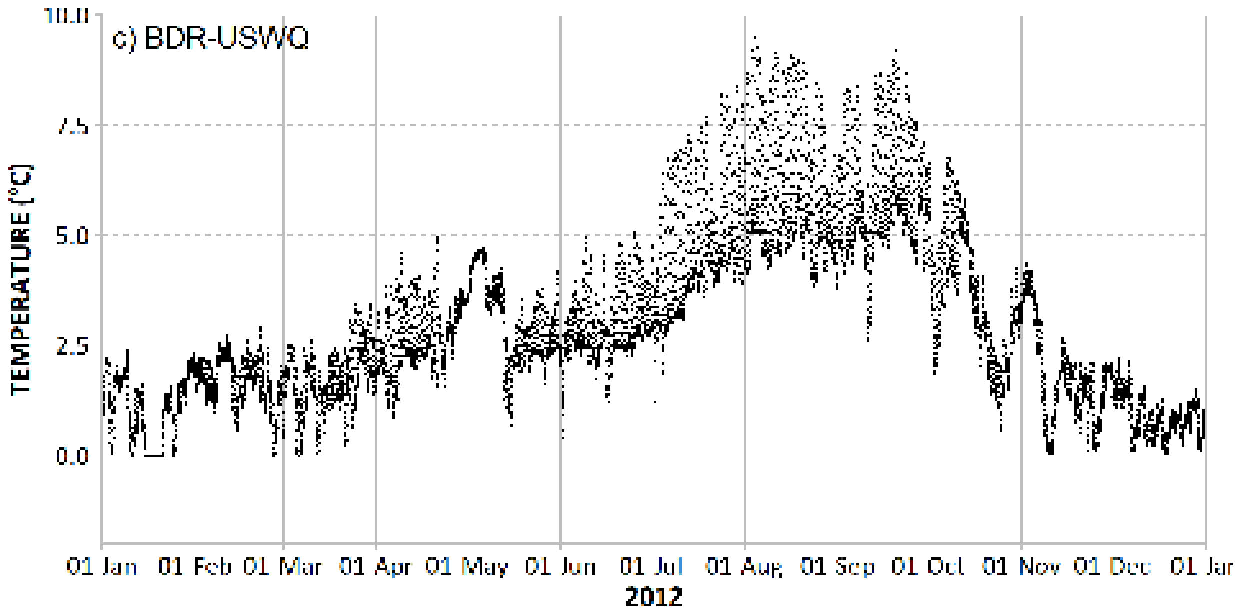

c) NTH-USWQ1
TEMPERATURE (°C)
0
5
10
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2020

Figure 10. Baseline water temperature at BDR-USWQ from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.






c) BDR-USWQ
10.0
7.5
5.0
2.5
0.0
TEMPERATURE (°C)
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2012

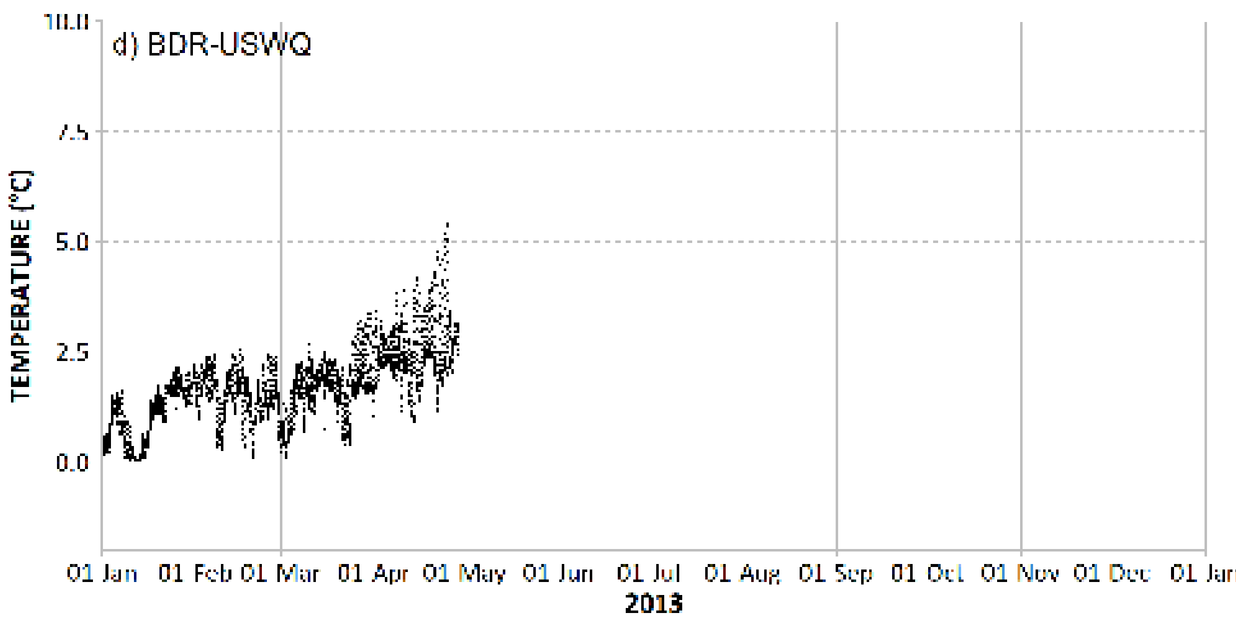

d) BDR-USWQ
10.0
7.5
5.0
2.5
0.0
TEMPERATURE (°C)
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2013

Figure 11. **Operational water temperature at BDR-USWQ2 from 2019 to 2020. Black dots show water temperature at intervals of 15 minutes.**

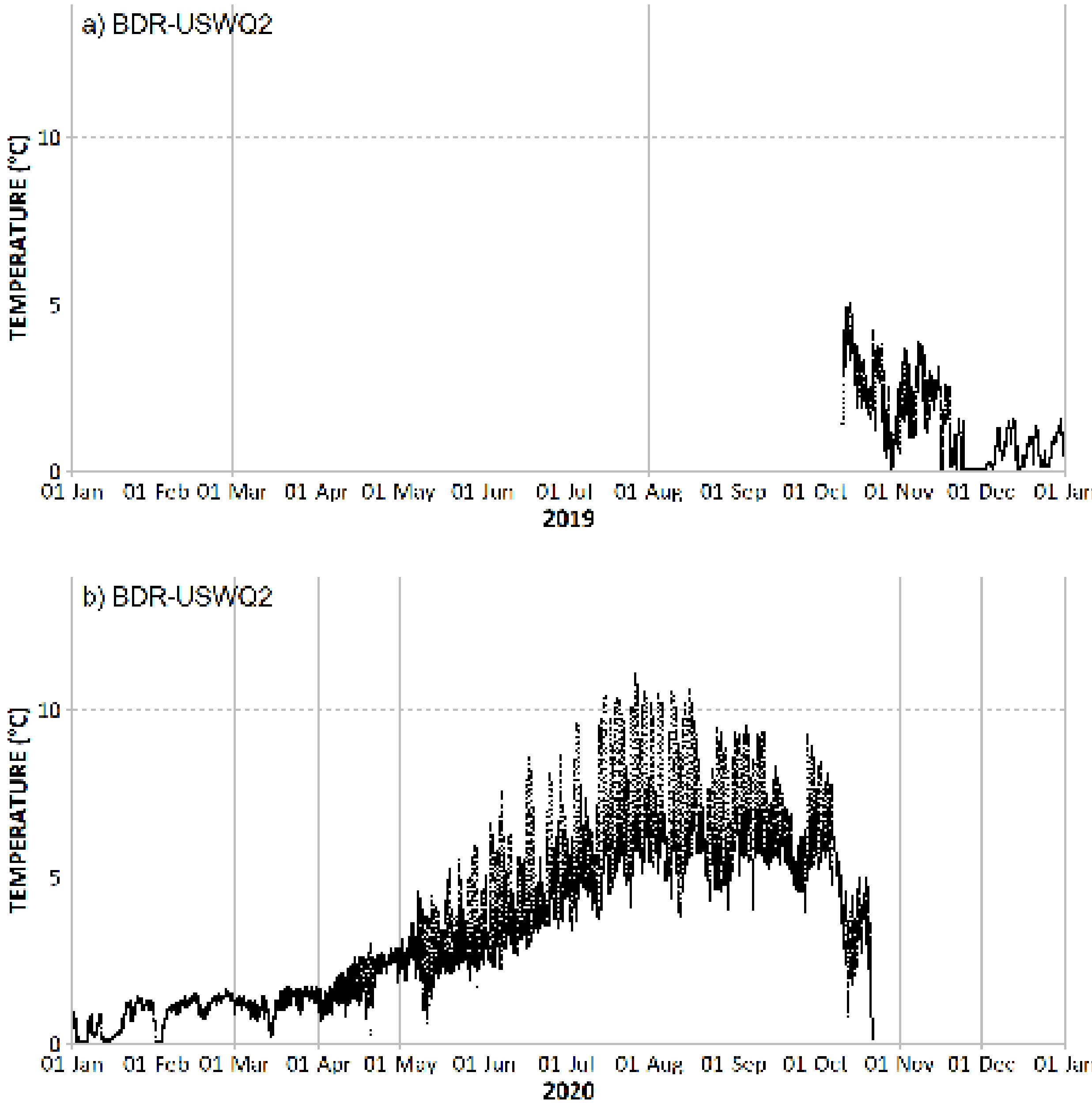
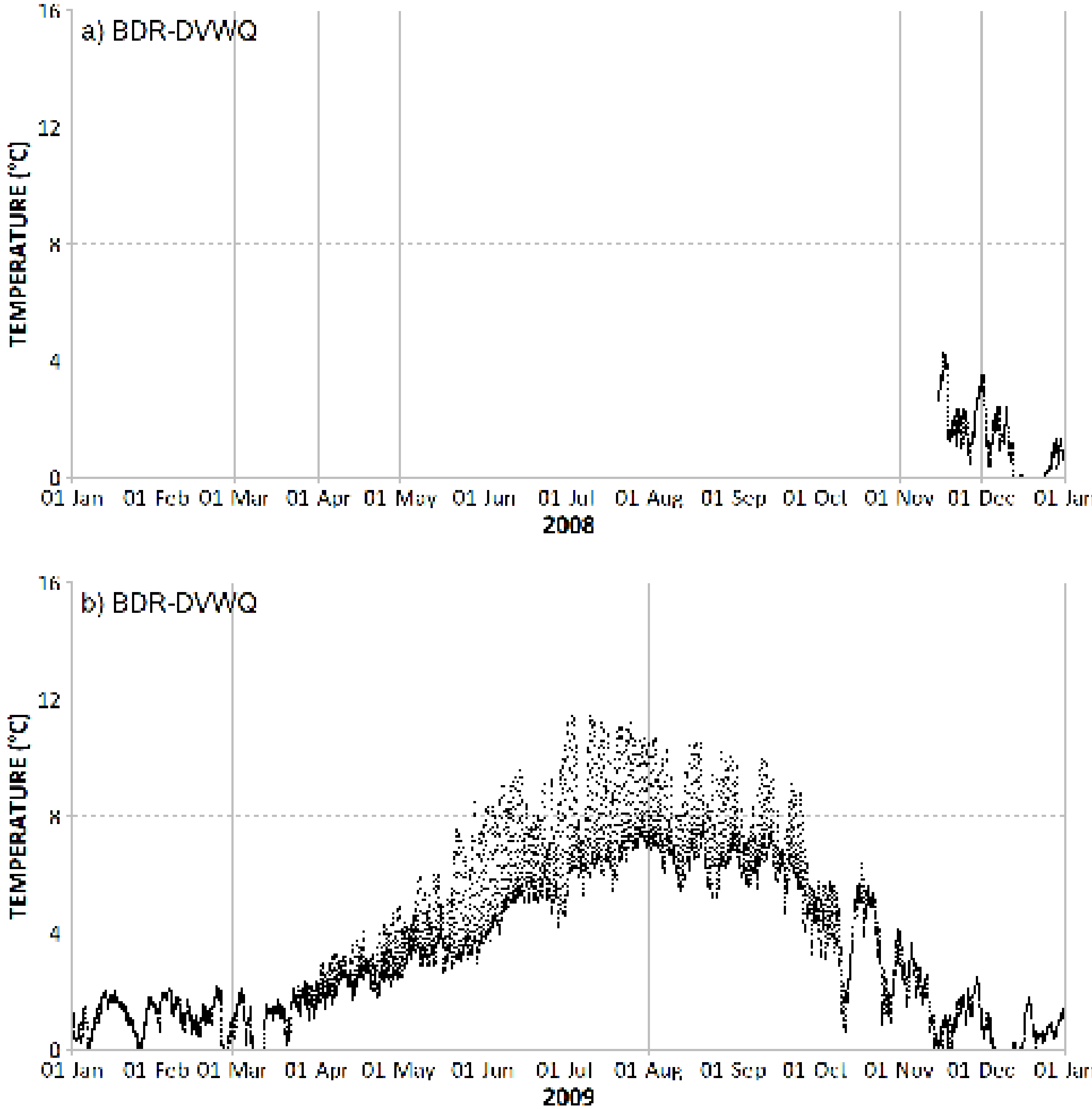
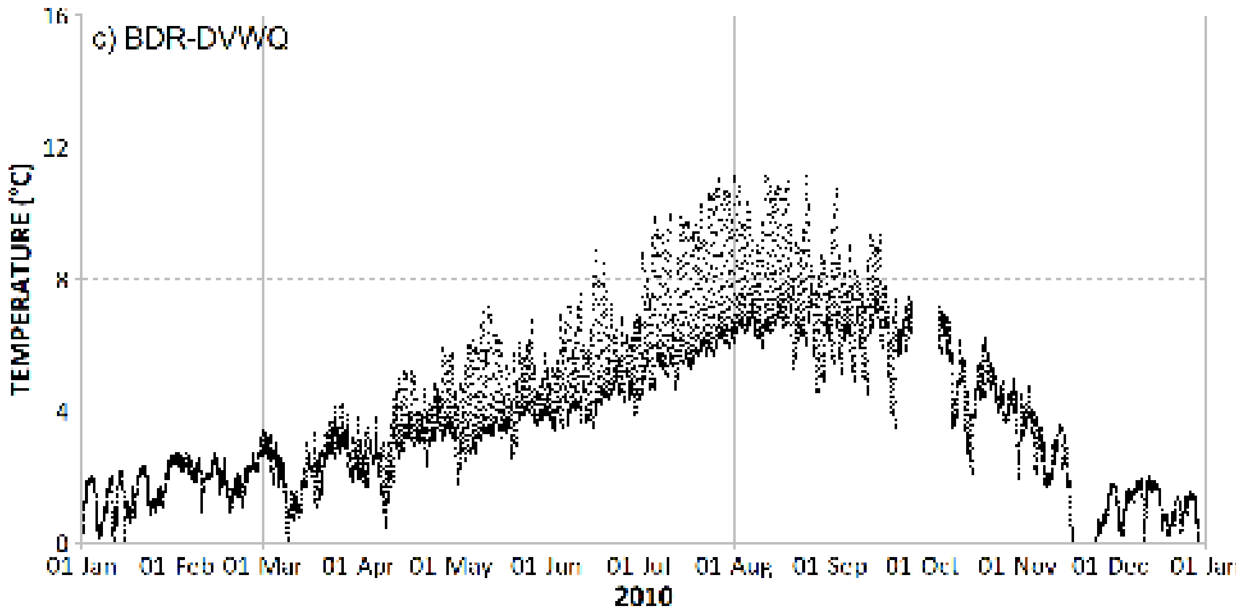
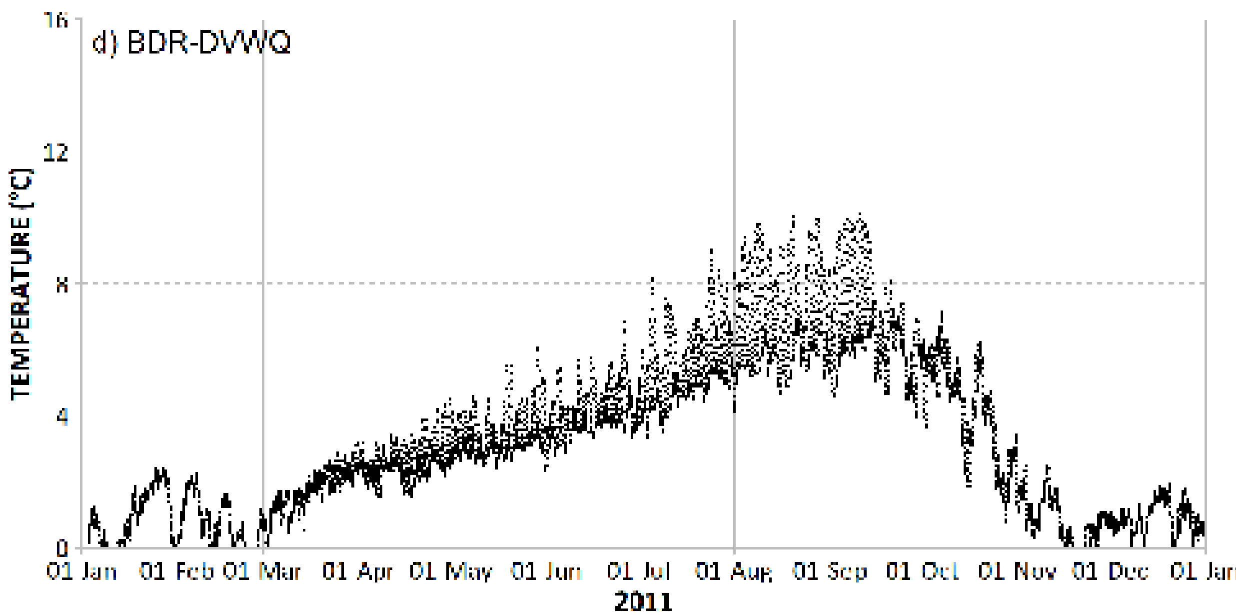
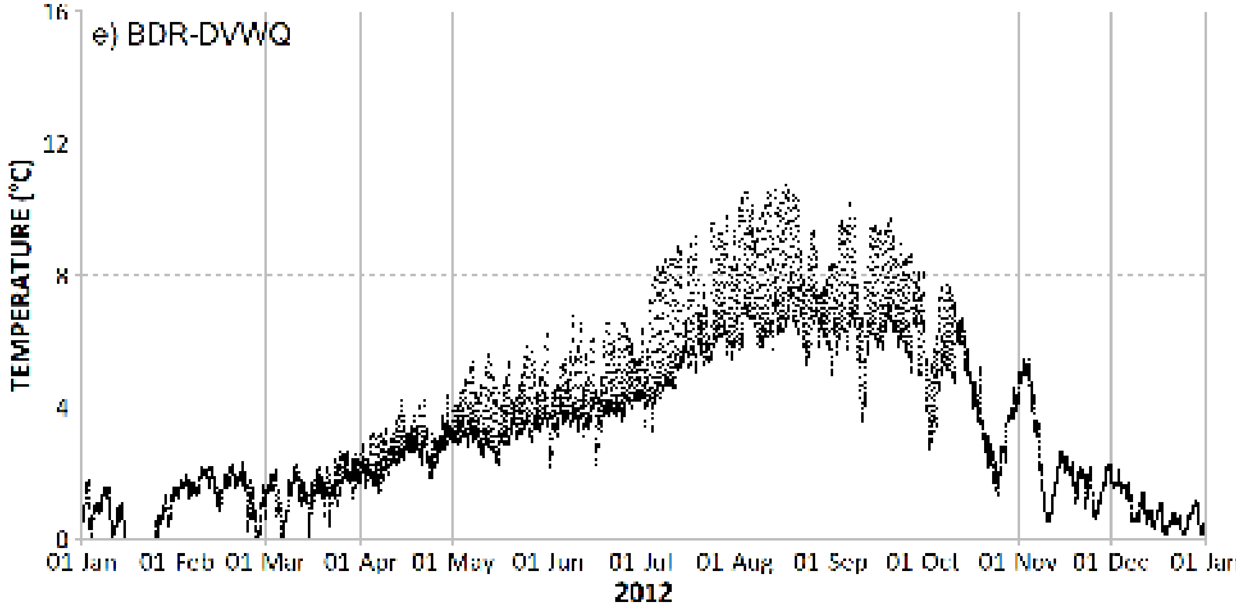


Figure 12. Baseline water temperature at BDR-DVWQ from 2008-2013. Black dots show water temperature at intervals of 15 minutes.




c) BDR-DVWQ
TEMPERATURE (°C)
16
12
8
4
0
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2010


d) BDR-DVWQ
TEMPERATURE (°C)
16
12
8
4
0
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2011


e) BDR-DVWQ
TEMPERATURE (°C)
16
12
8
4
0
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2012

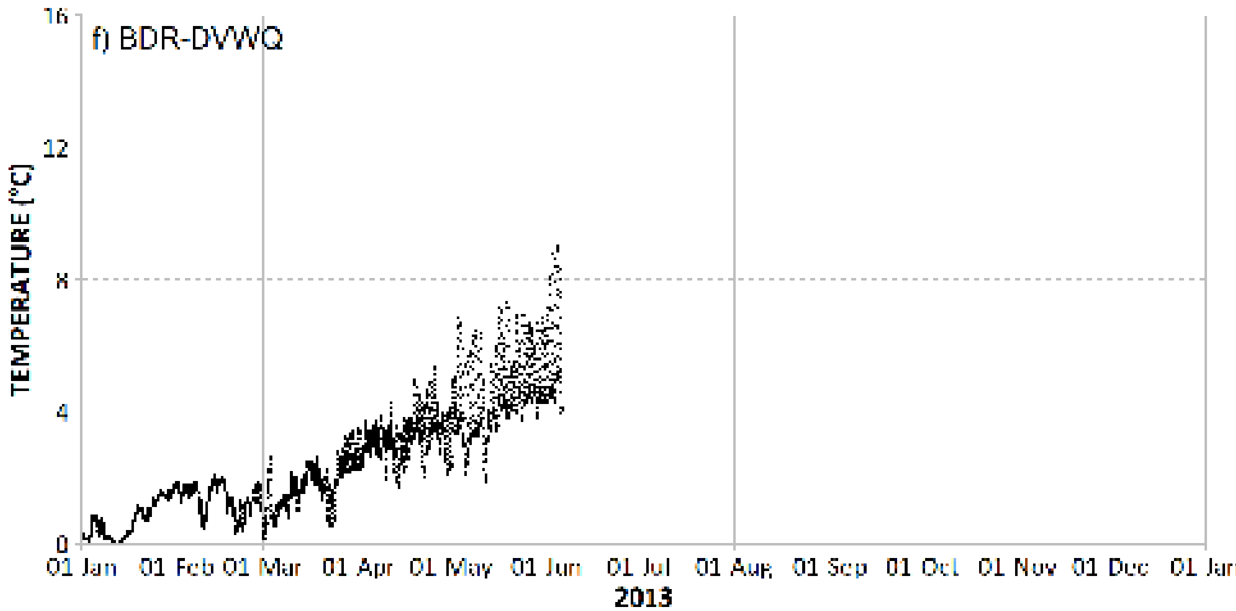
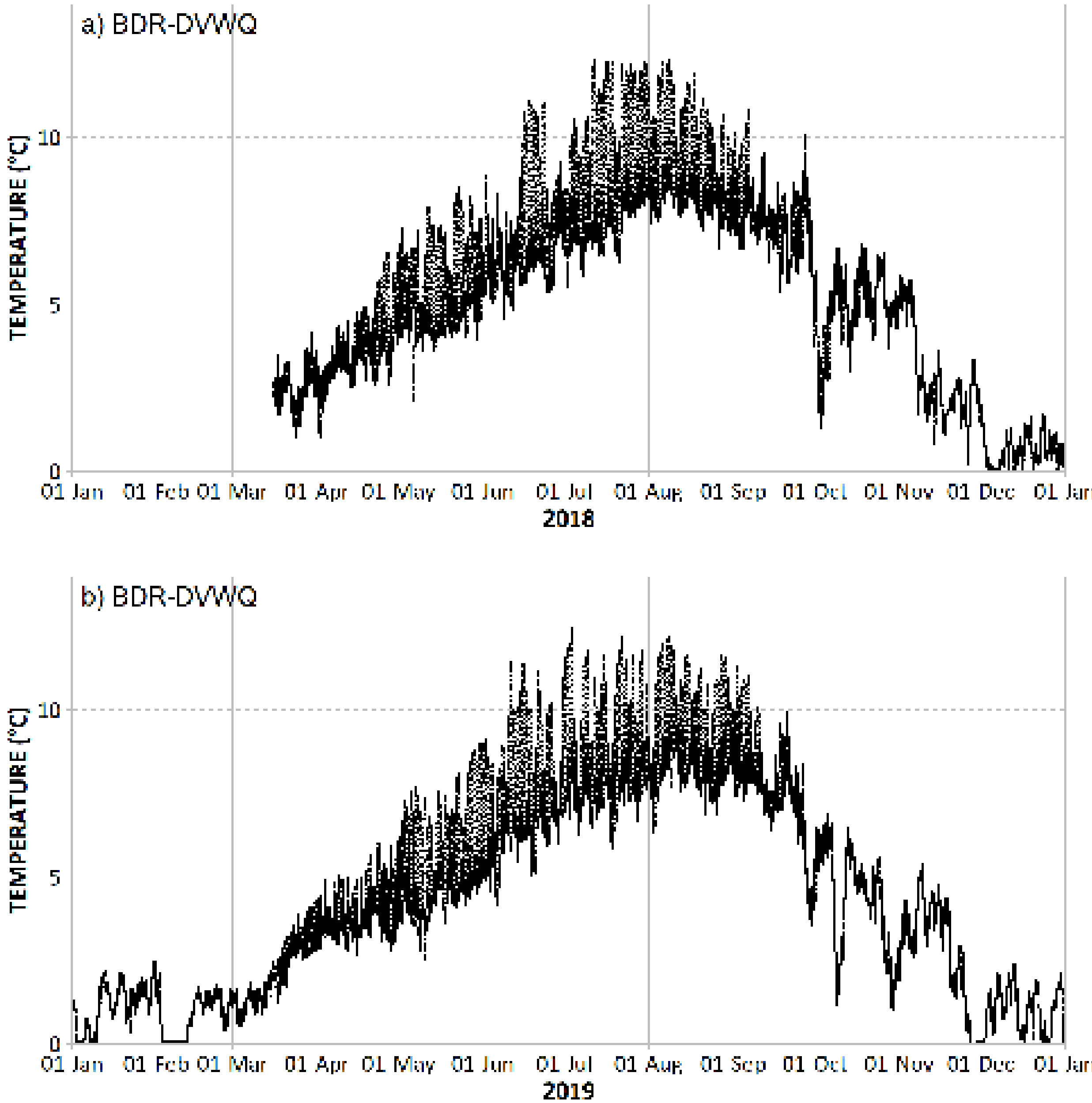

f) BDR-DVWQ
TEMPERATURE (°C)
16
12
8
4
0
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2013

Figure 13. Operational water temperature at BDR-DVWQ from 2018-2020. Black dots show water temperature at intervals of 15 minutes.



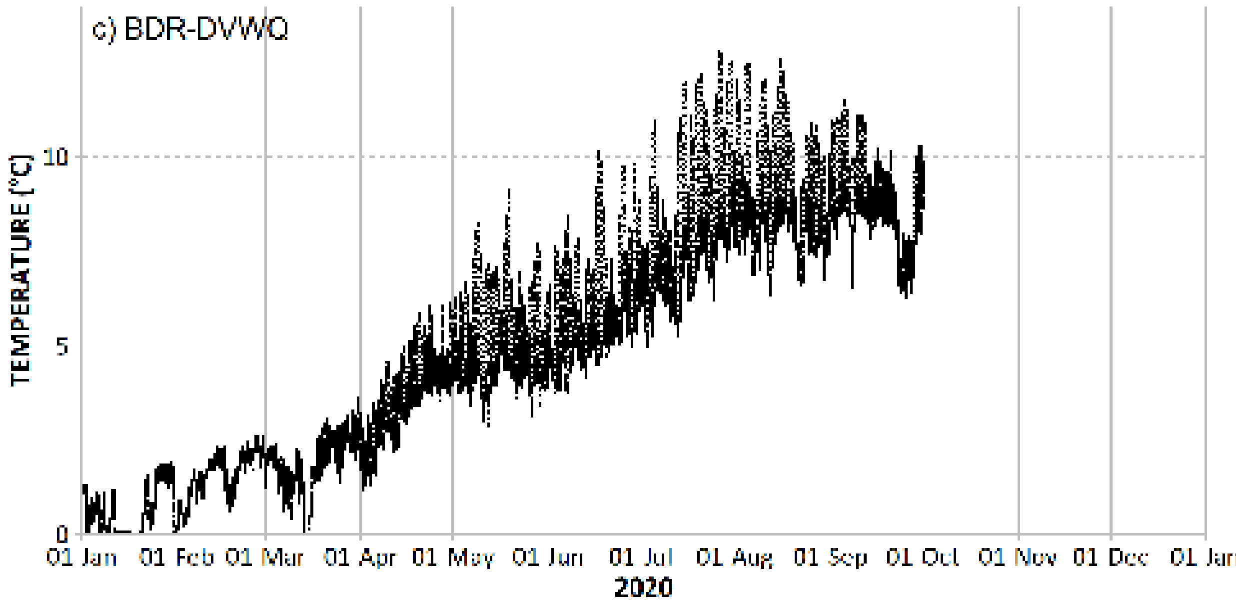
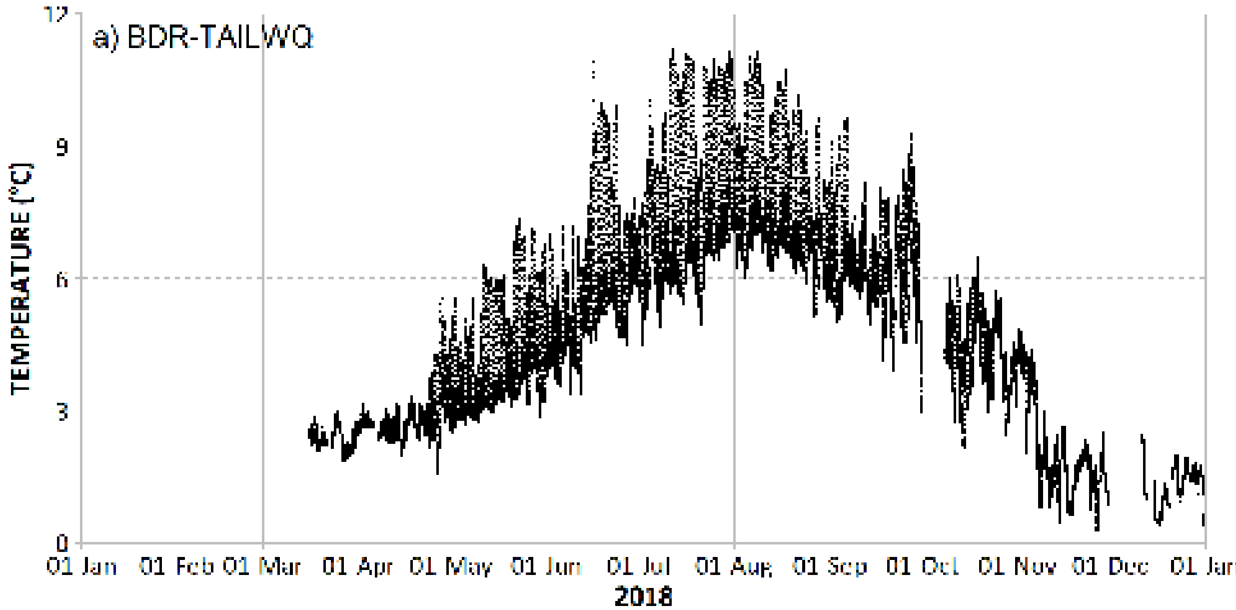
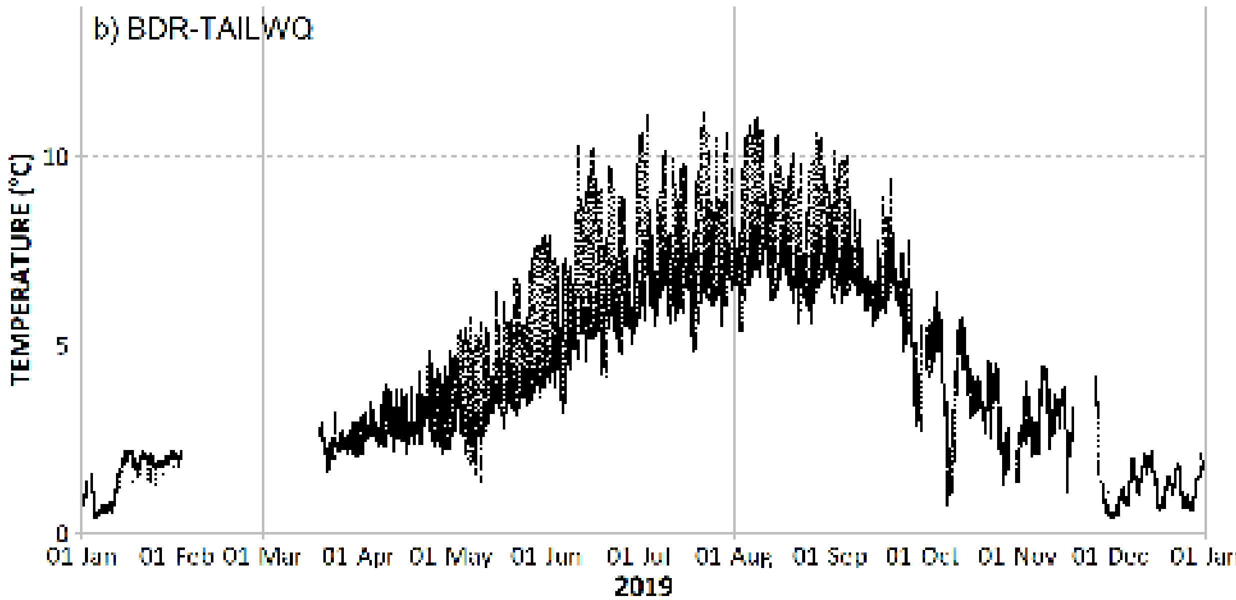


Figure 14. **Operational water temperature at BDR-TAILWQ from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.**




b) BDR-TAILWQ
TEMPERATURE (°C)
0
5
10
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2019

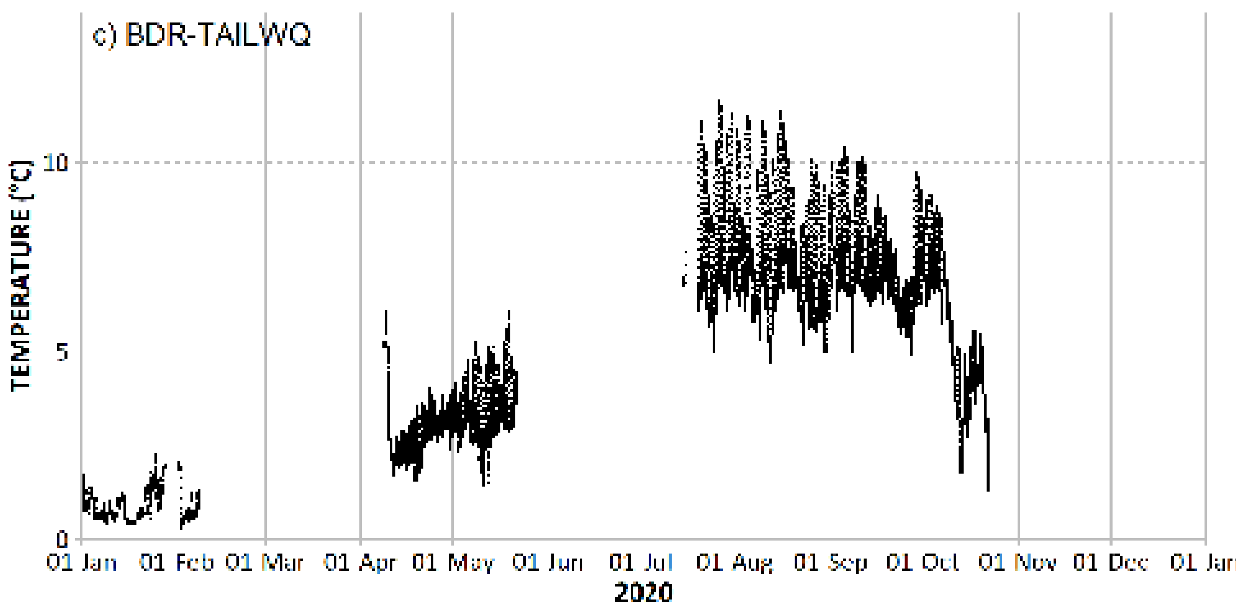
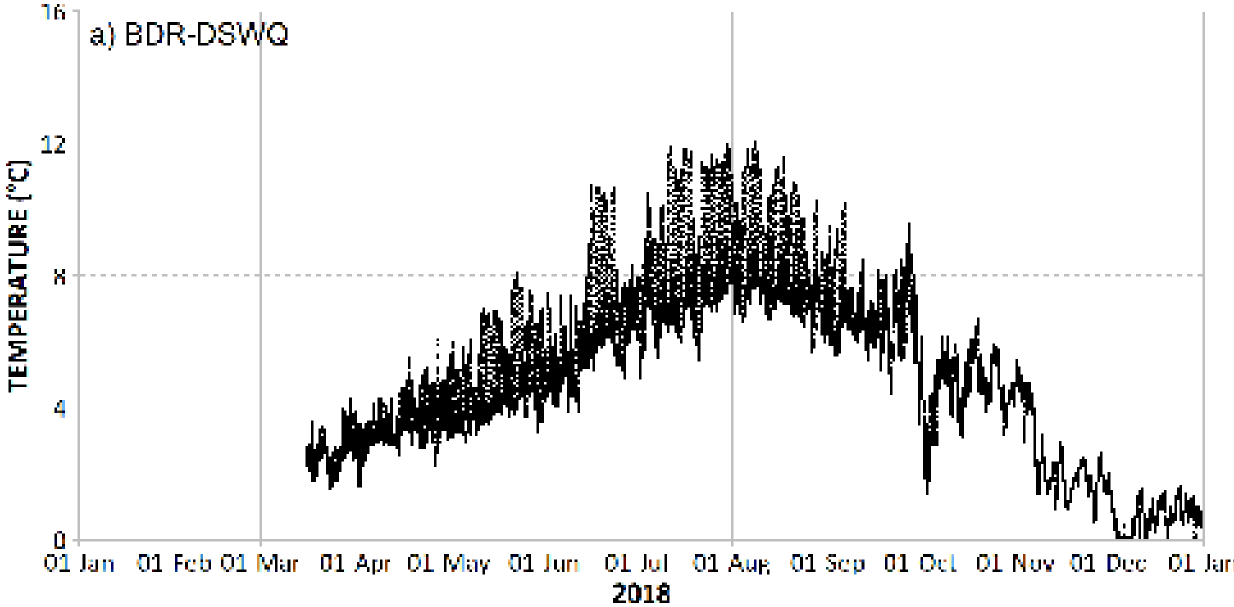
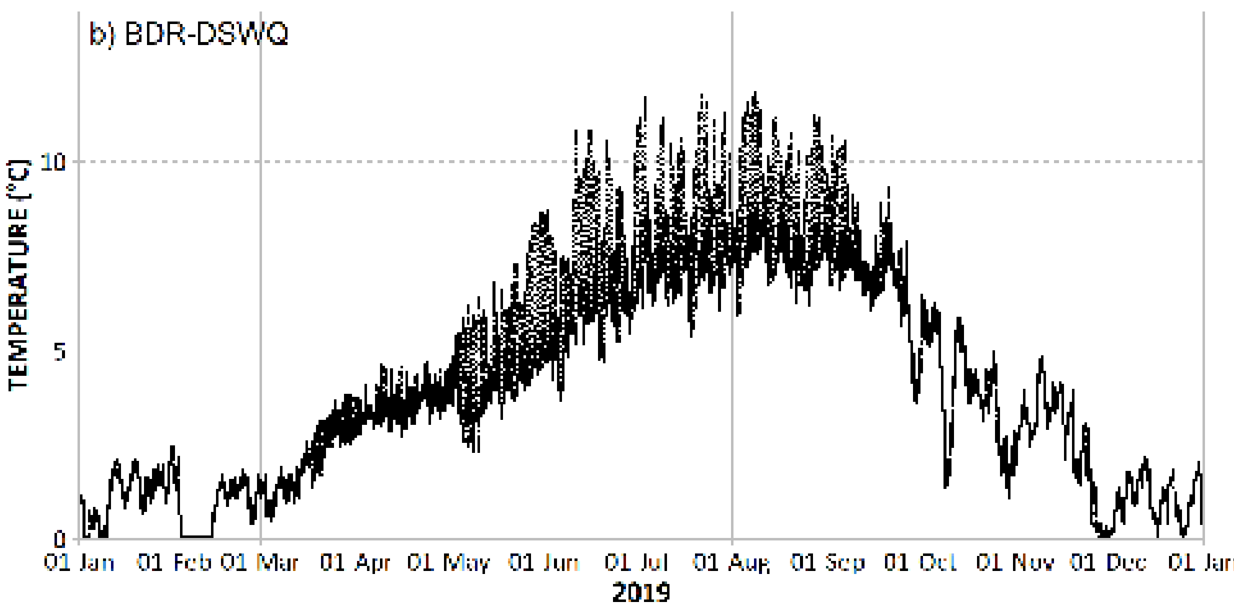
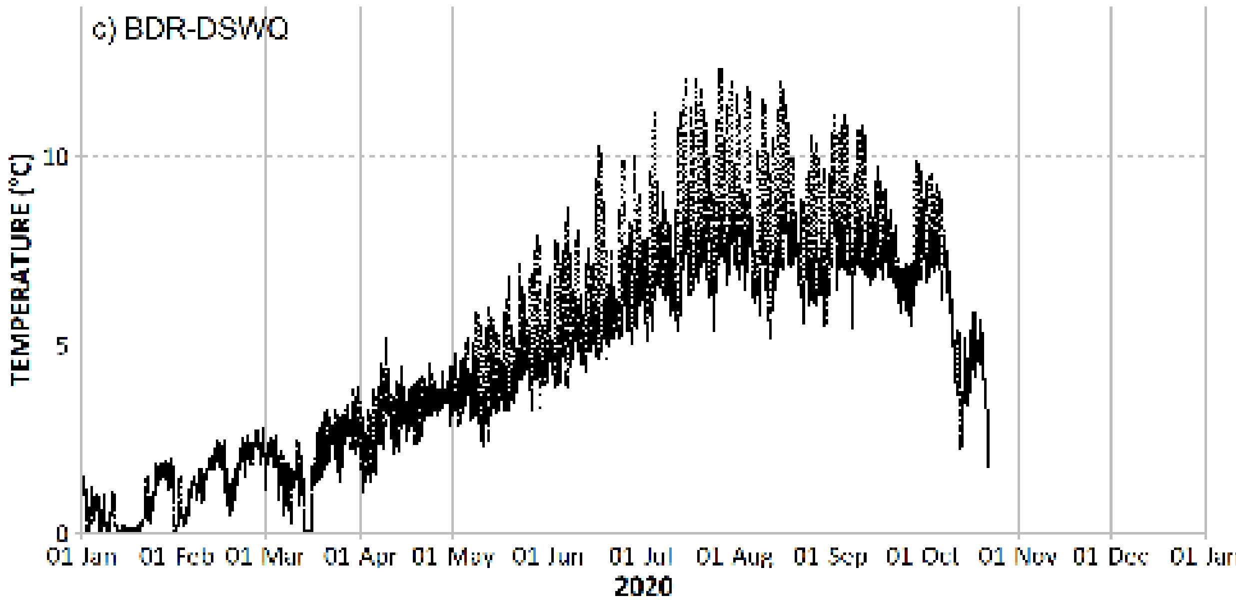

c) BDR-TAILWQ
TEMPERATURE (°C)
0
5
10
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2020

Figure 15. **Operational water temperature at BDR-DSWQ from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.**



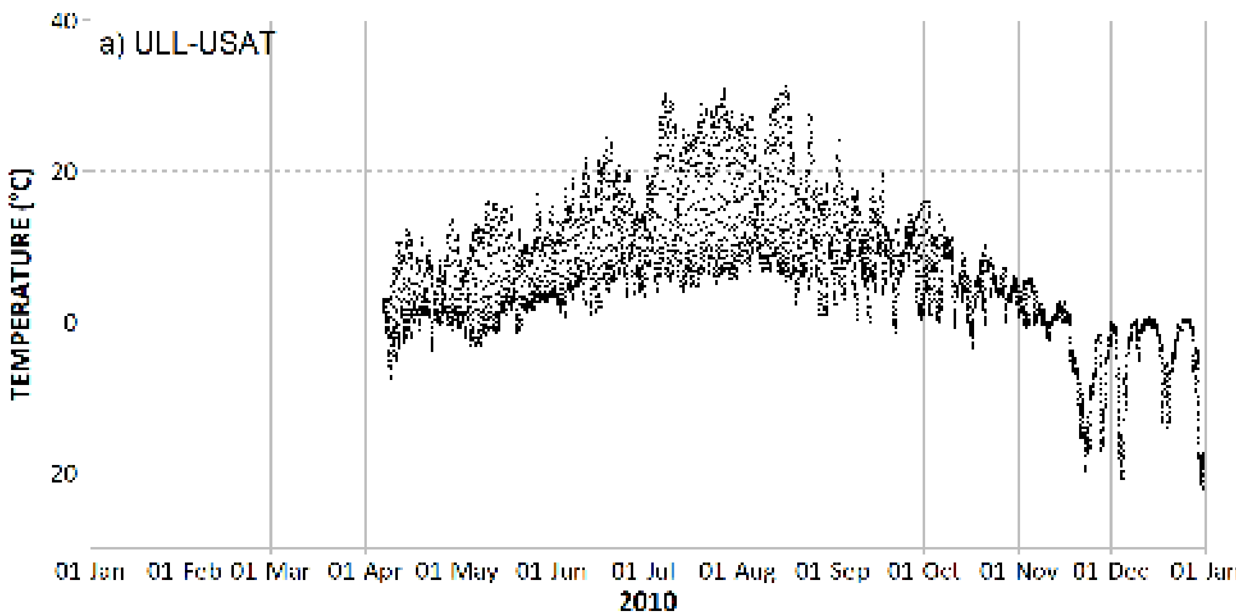


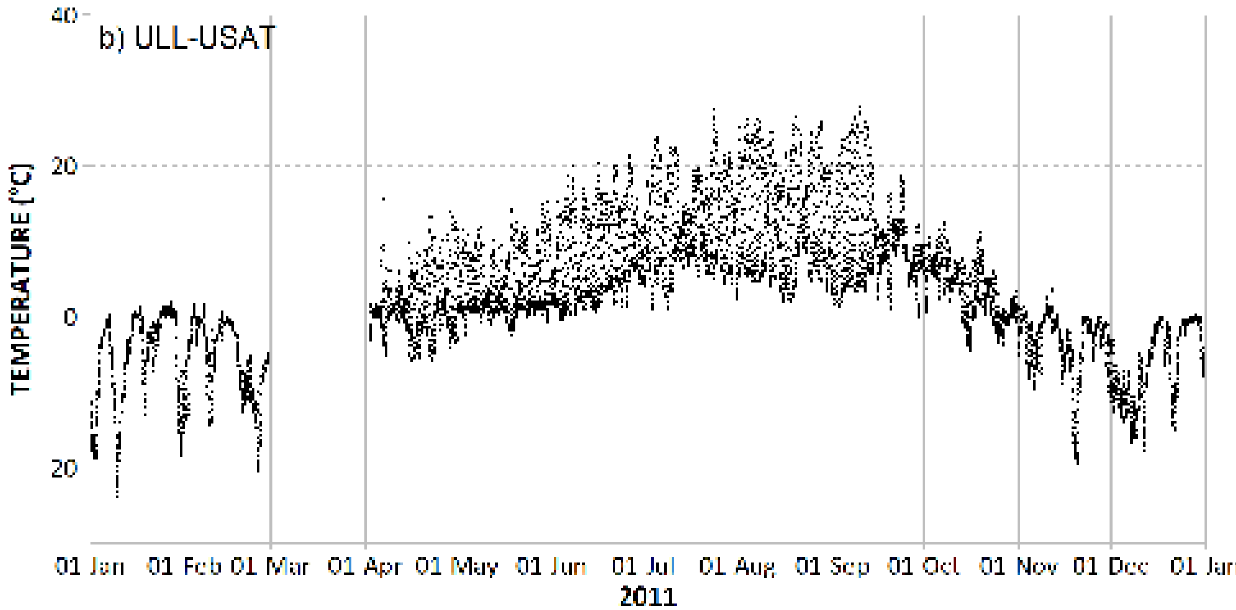


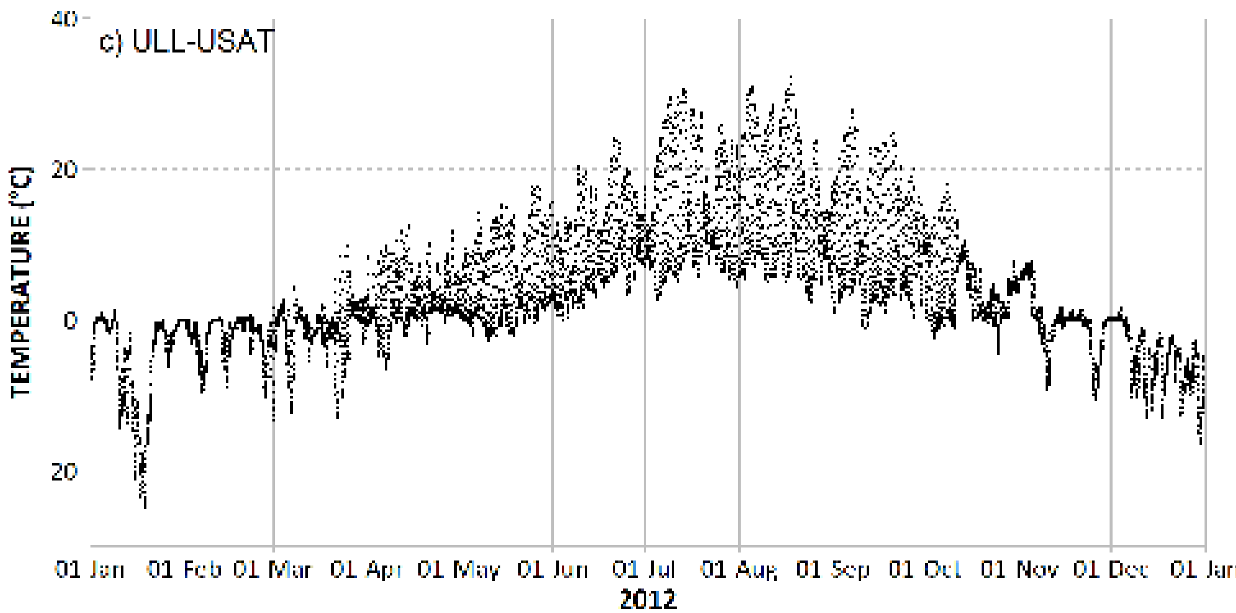
3. AIR TEMPERATURE DATA

3.1. Upper Lillooet River

Figure 16. **Baseline air temperature at ULL-USAT from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.**




b) ULL-USAT
TEMPERATURE (°C)
40
20
0
20
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2011


c) ULL-USAT
TEMPERATURE (°C)
40
20
0
20
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2012

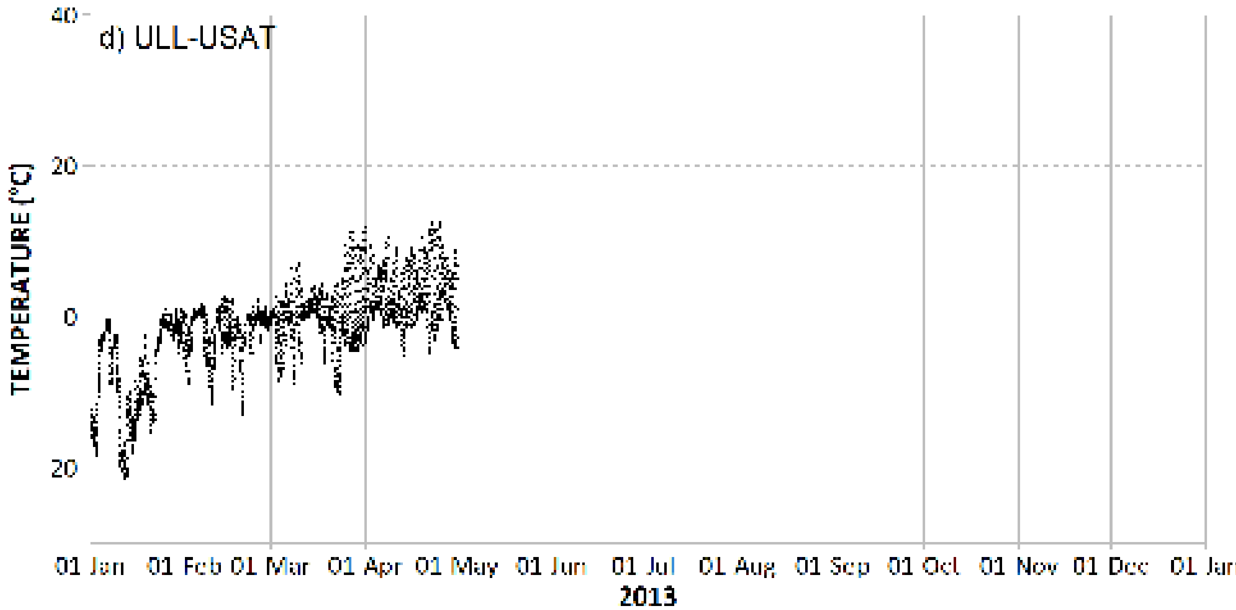
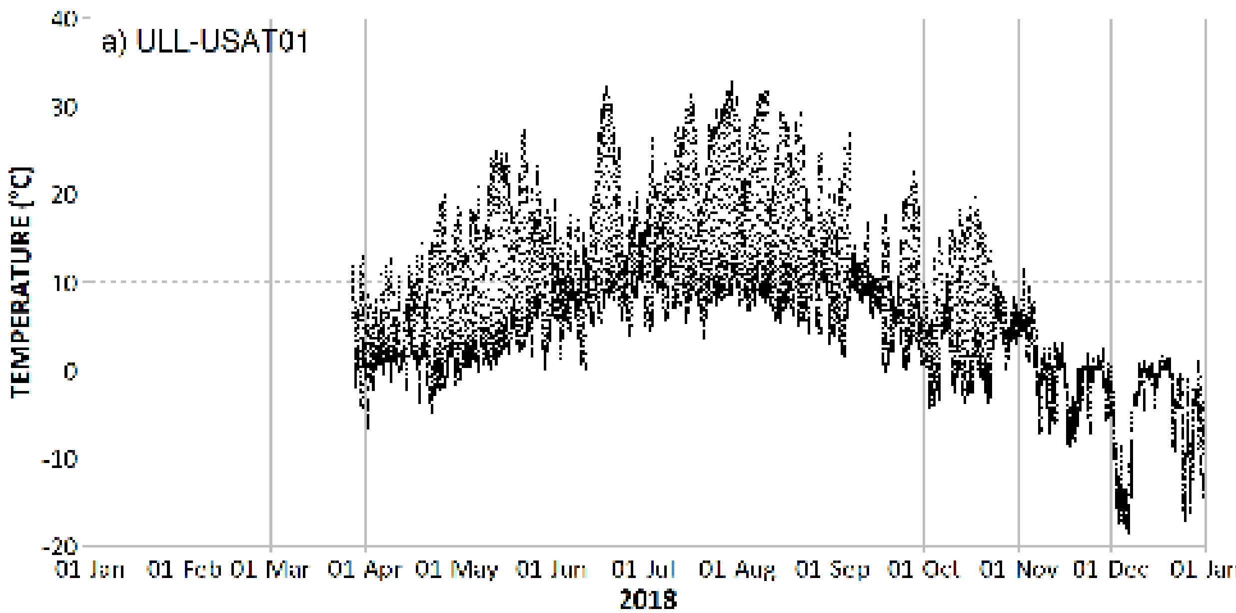


Figure 17. Operational air temperature at ULL-USAT01 from 2018 to 2019. Black dots show water temperature at intervals of 15 minutes.



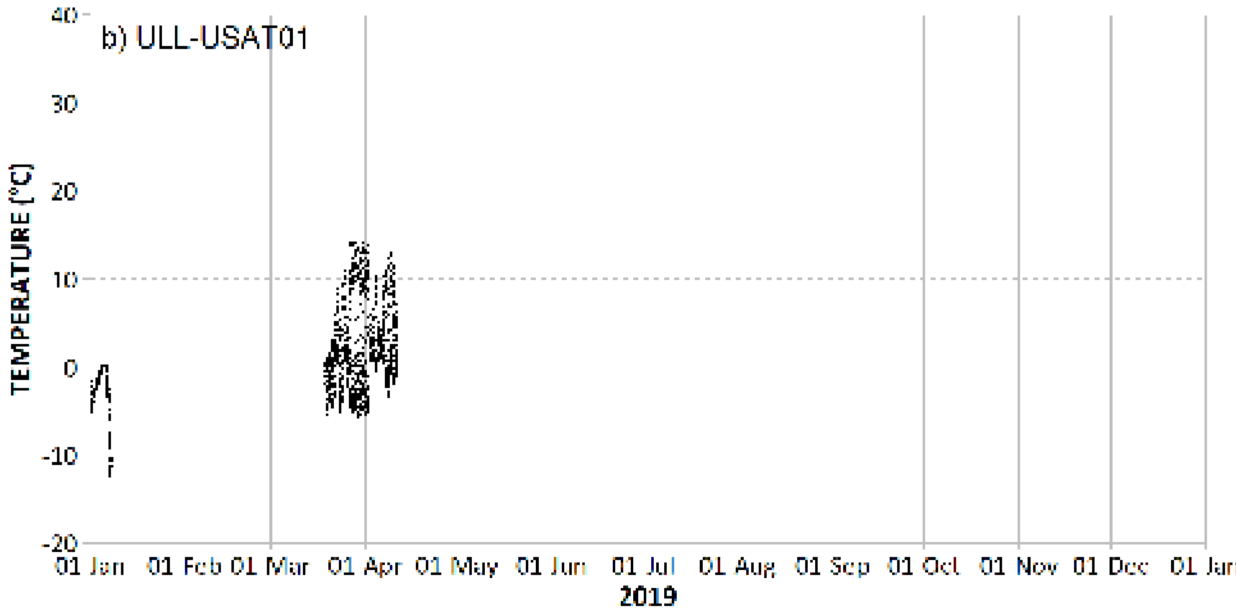
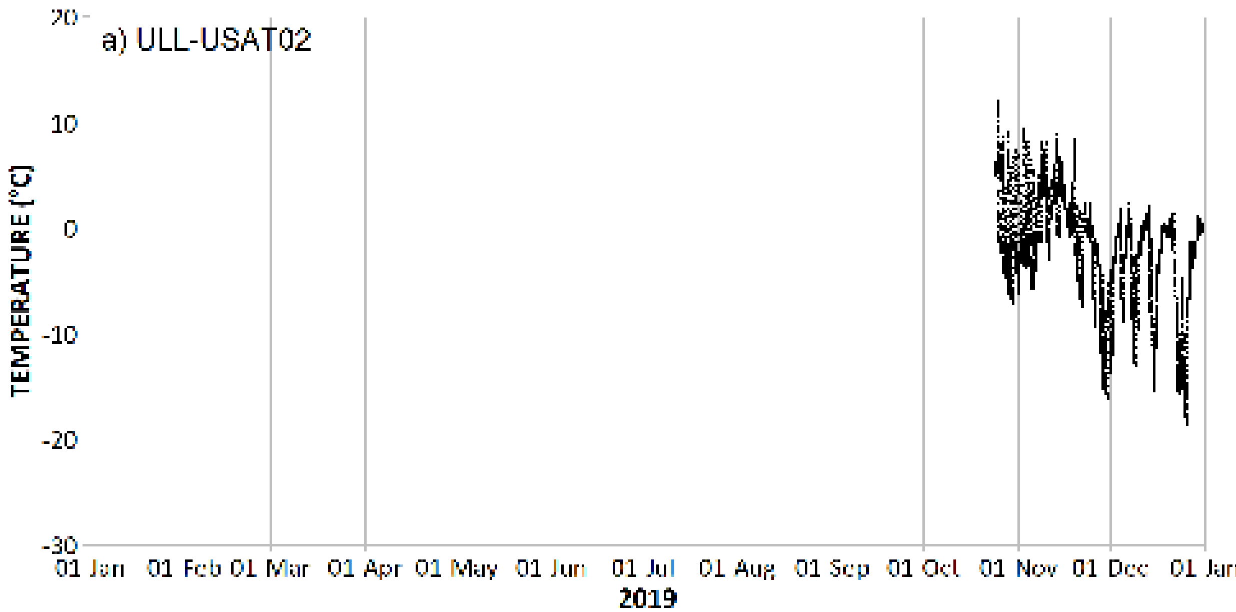


Figure 18. Operational air temperature at ULL-USAT02 from 2019 to 2020. Black dots show water temperature at intervals of 15 minutes.



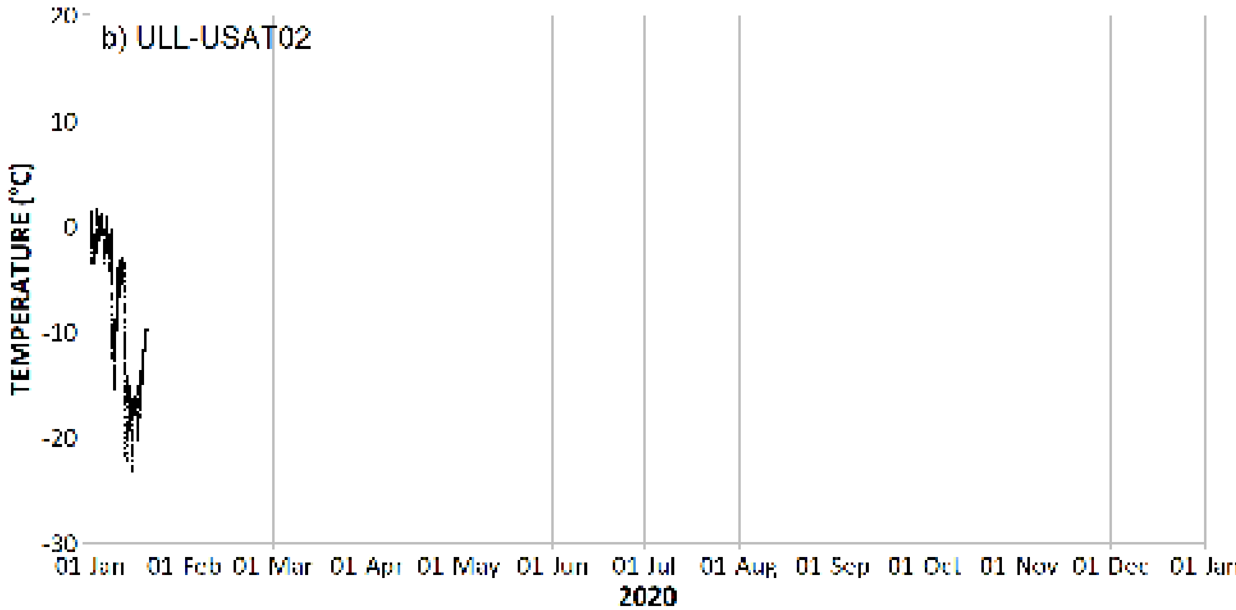
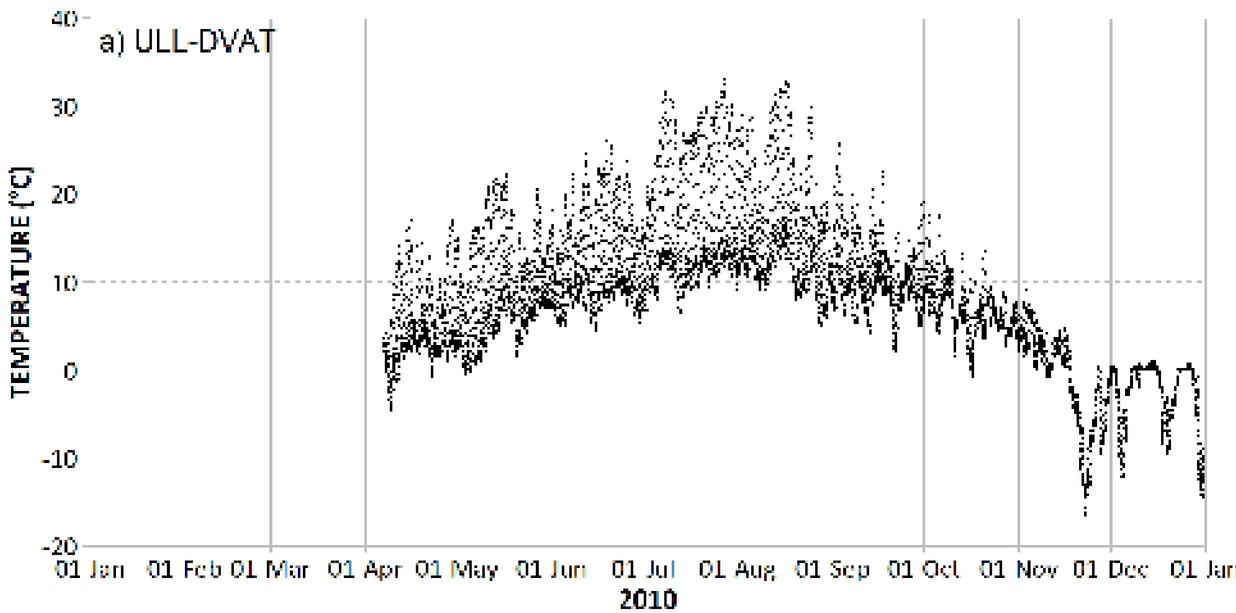
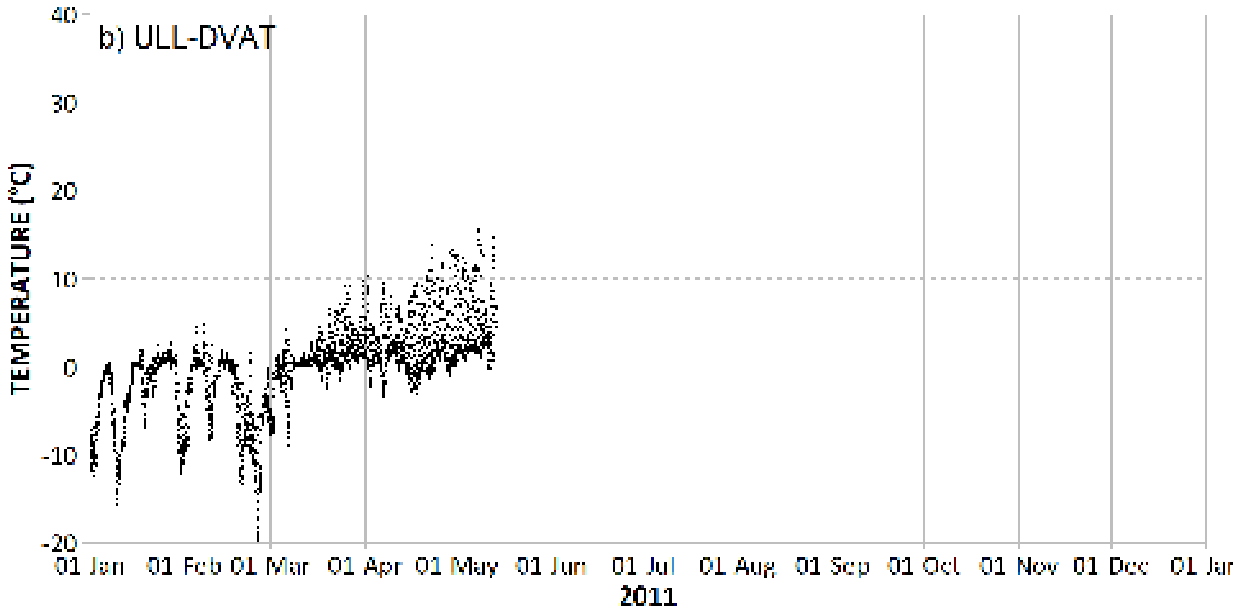
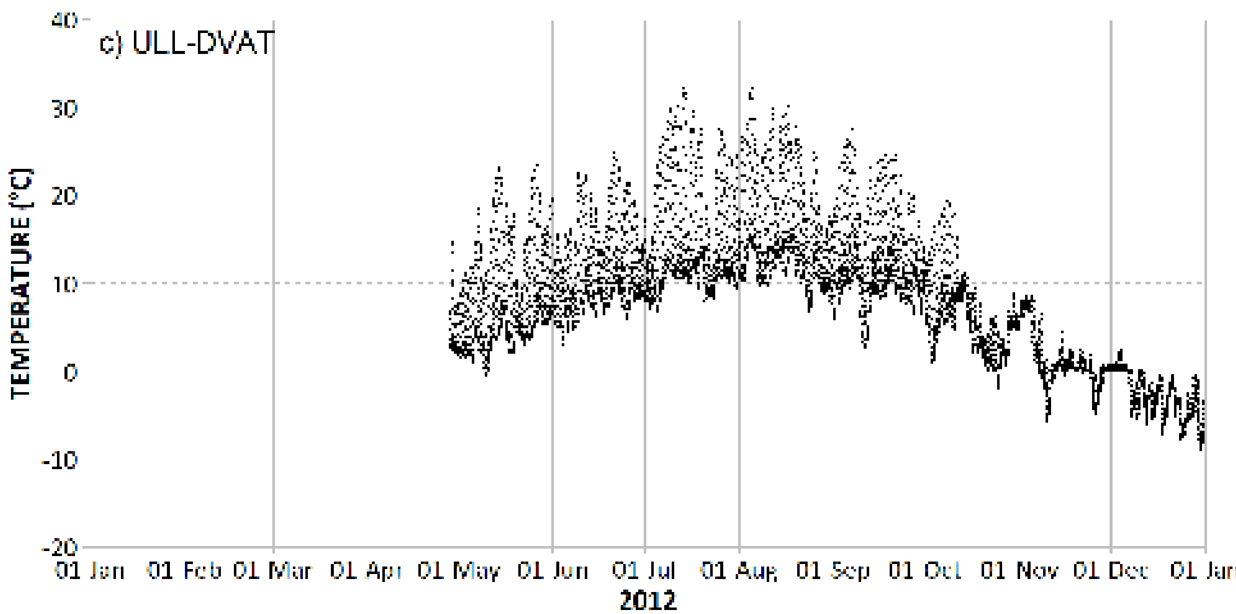


Figure 19. **Baseline air temperature at ULL-DVAT from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.**




b) ULL-DVAT
TEMPERATURE (°C)
40
30
20
10
0
-10
-20
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2011


c) ULL-DVAT
TEMPERATURE (°C)
40
30
20
10
0
-10
-20
01 Jan 01 Feb 01 Mar 01 Apr 01 May 01 Jun 01 Jul 01 Aug 01 Sep 01 Oct 01 Nov 01 Dec 01 Jan
2012

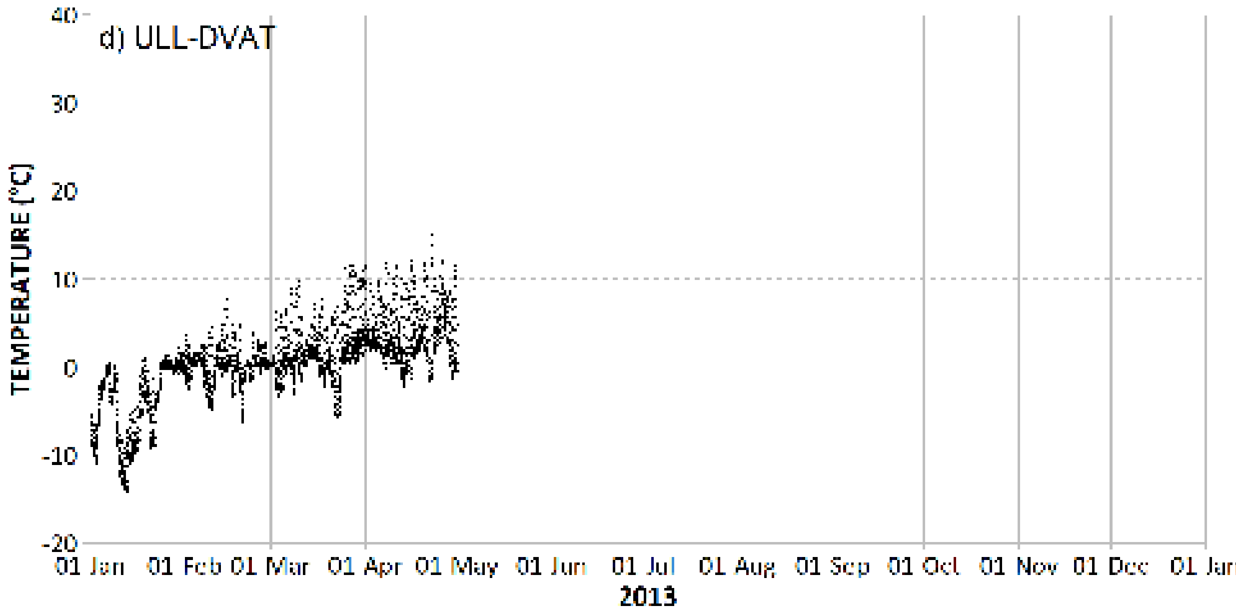
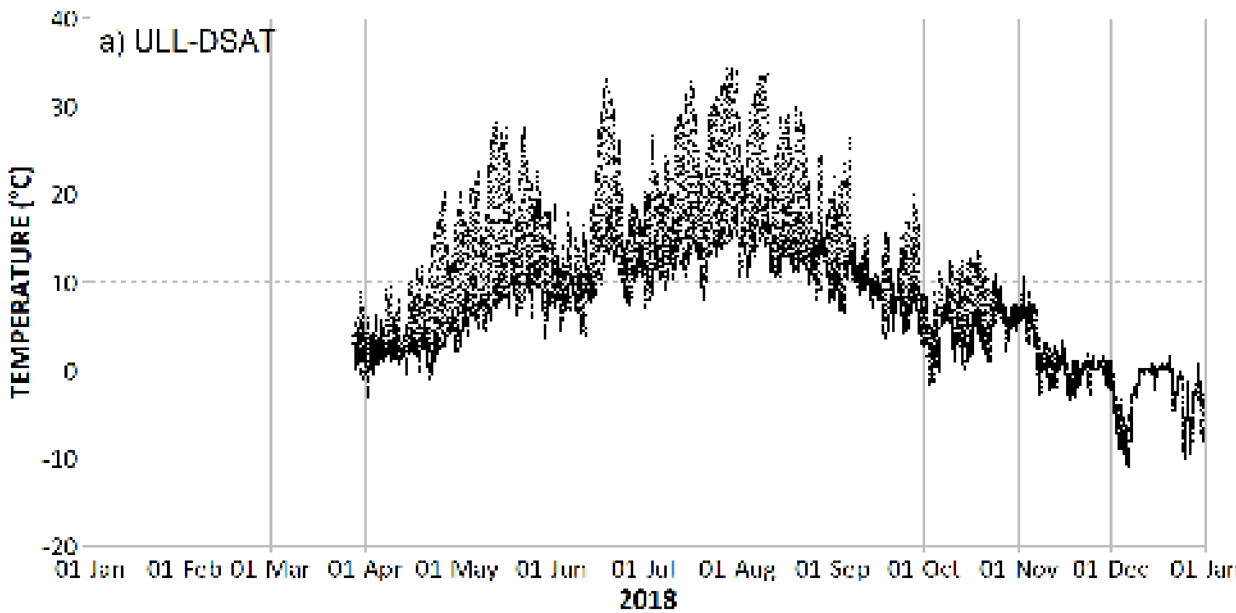
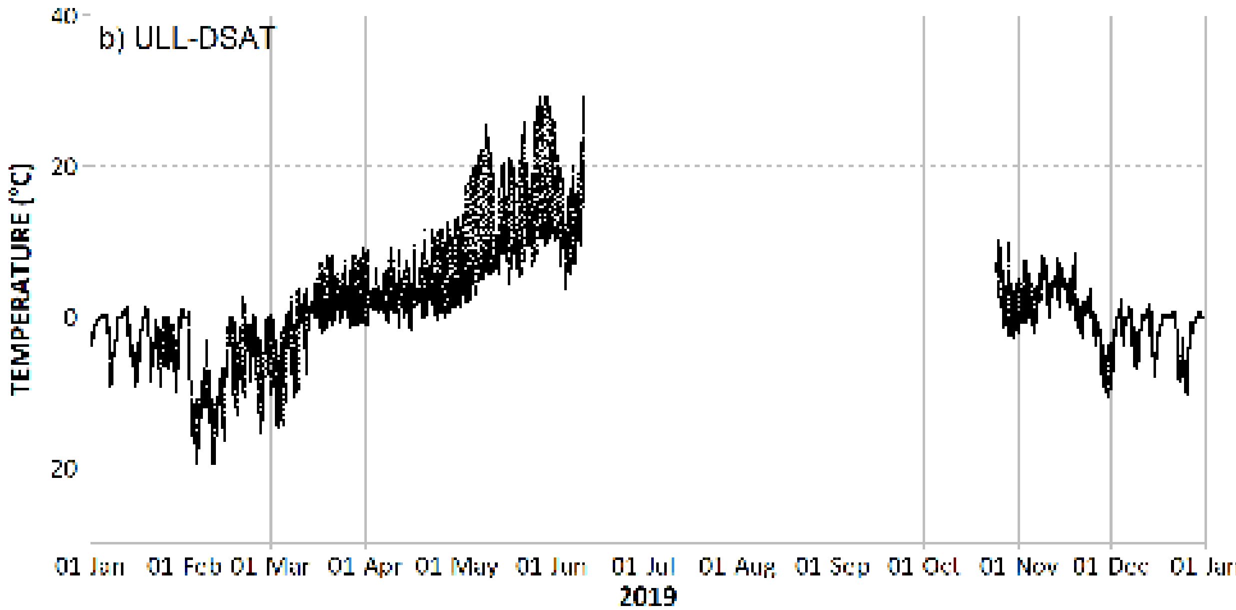
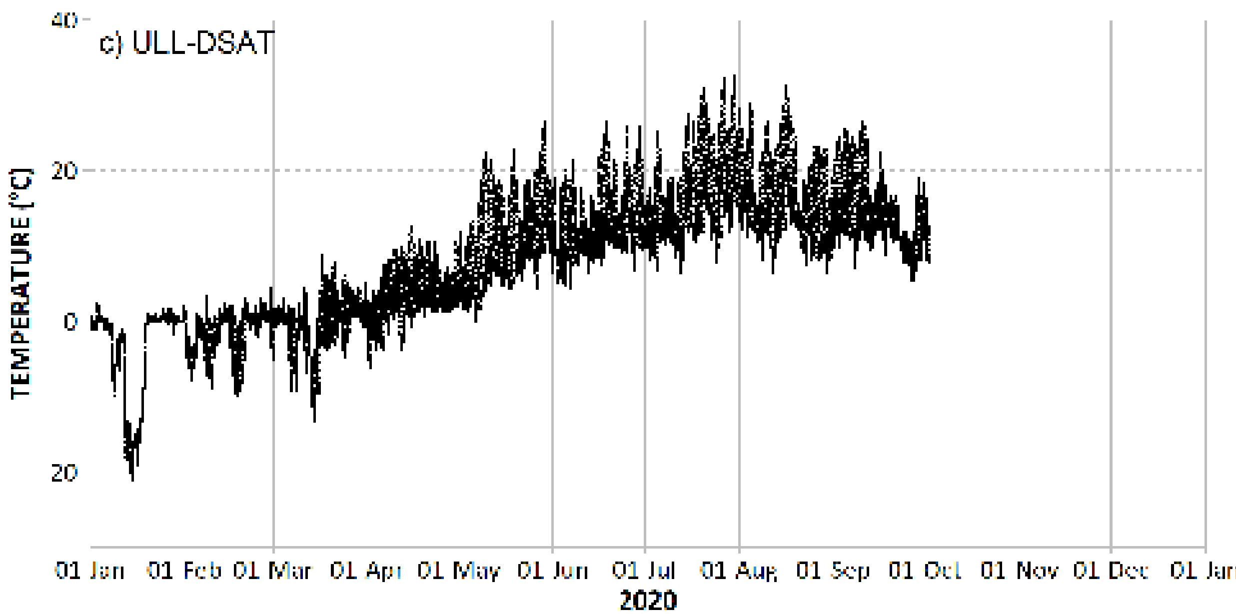


Figure 20. Operational air temperature at ULL-DSAT from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.





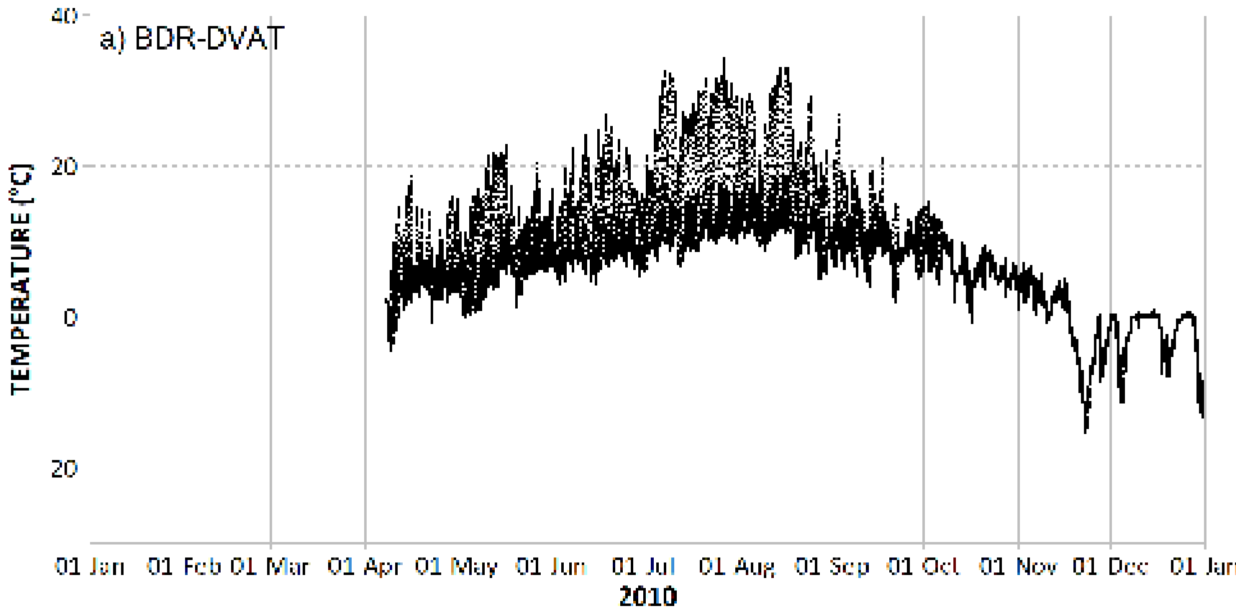
b) ULL-DSAT
TEMPERATURE (°C)
40
20
0
20
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2019

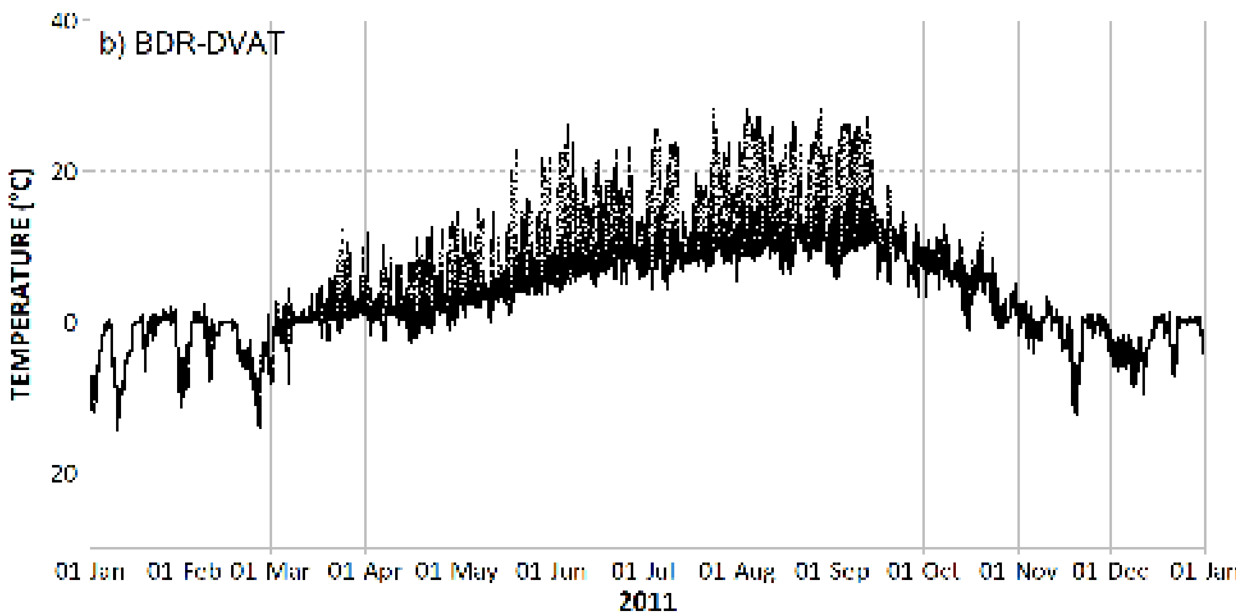


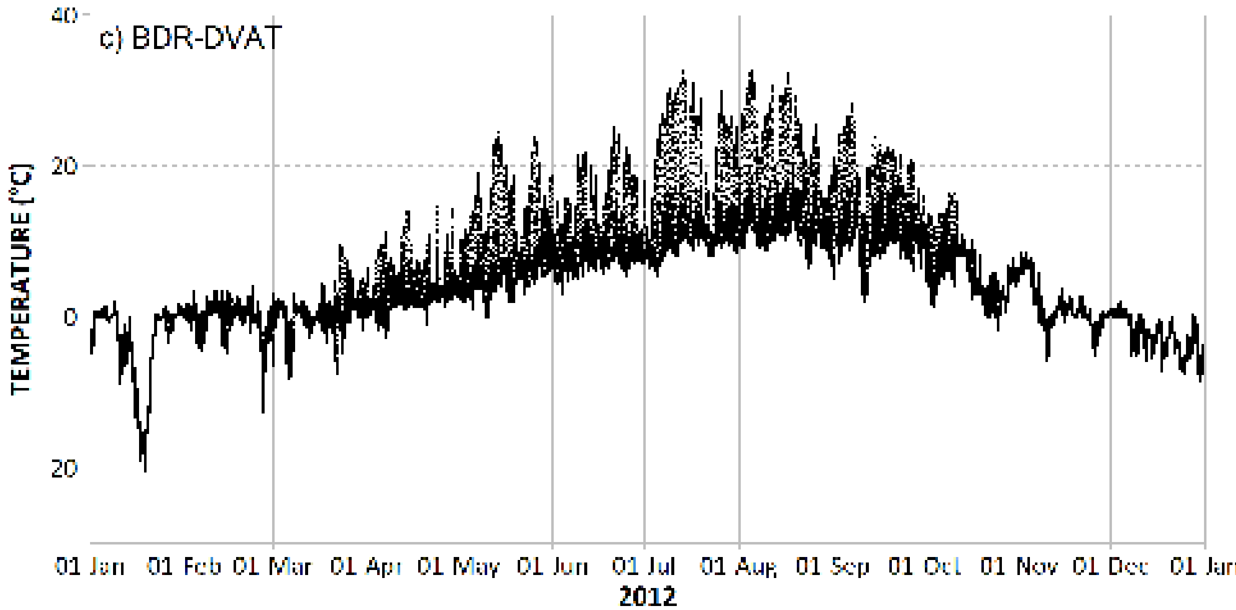
c) ULL-DSAT
TEMPERATURE (°C)
40
20
0
20
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2020

3.2. Boulder Creek

Figure 21. Baseline air temperature at BDR-DVAT from 2010 to 2013. Black dots show water temperature at intervals of 15 minutes.






c) BDR-DVAT
TEMPERATURE (°C)
40
20
0
20
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2012

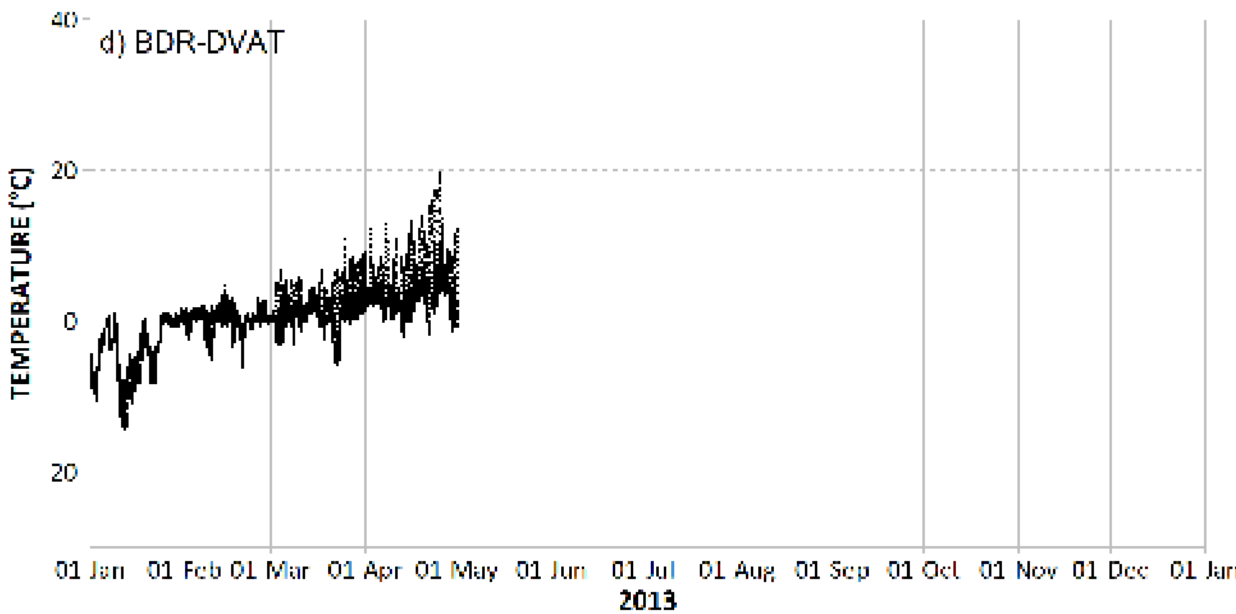
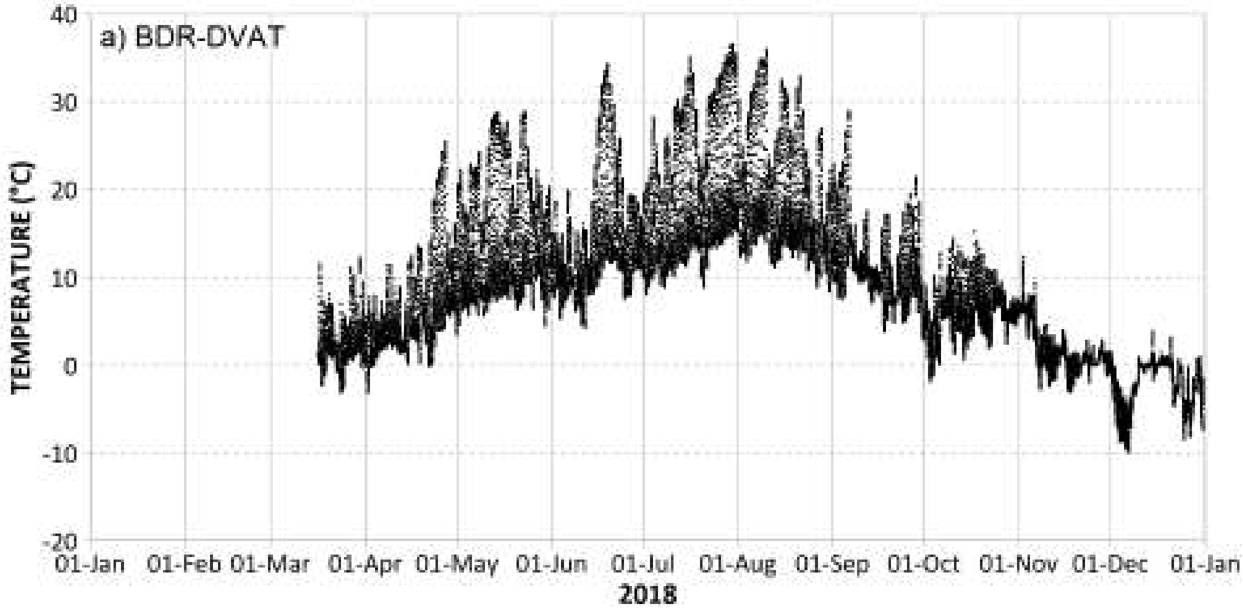
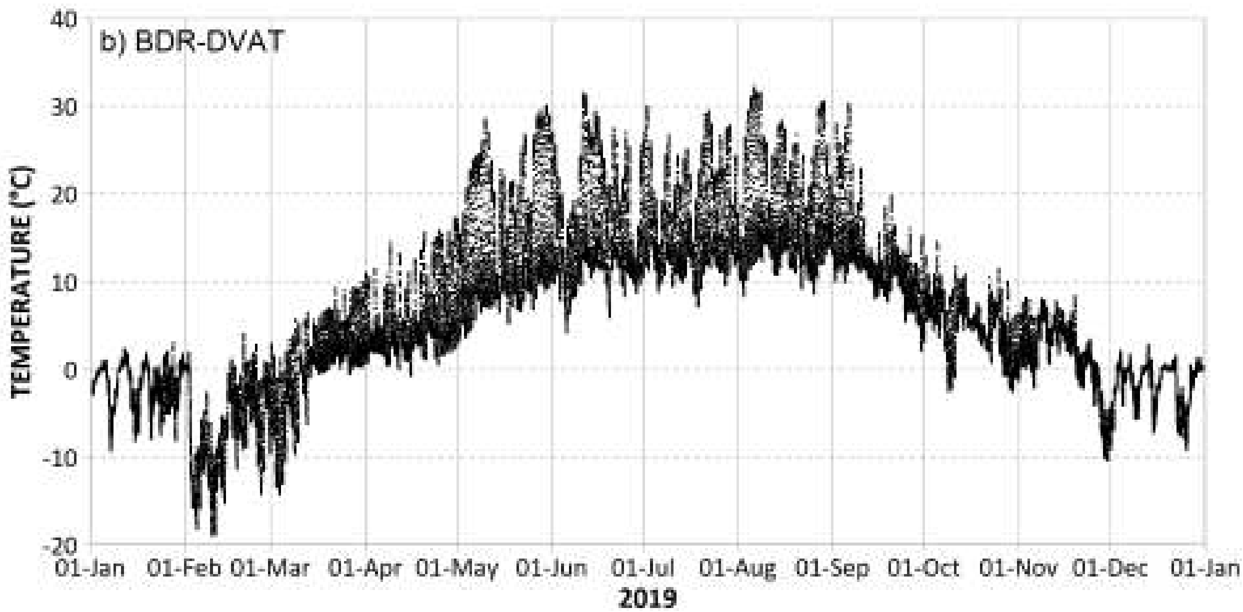
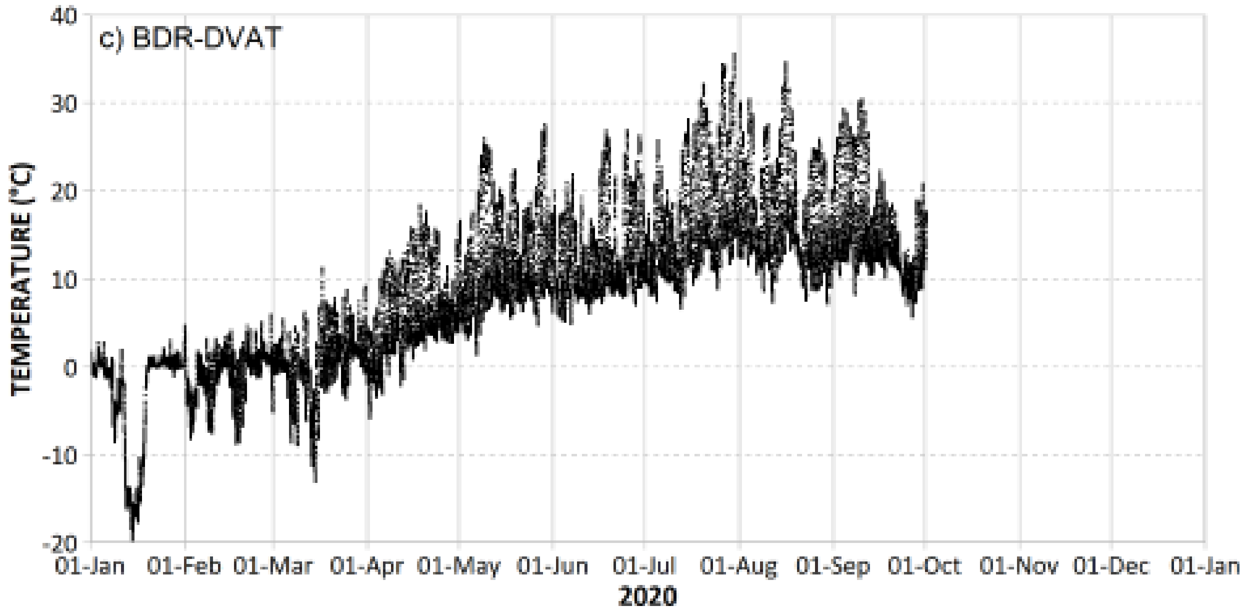

d) BDR-DVAT
TEMPERATURE (°C)
40
20
0
20
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
2013

Figure 22. Operational air temperature at BDR-DVAT from 2018 to 2020. Black dots show water temperature at intervals of 15 minutes.






c) BDR-DVAT
40
30
20
10
0
-10
-20
TEMPERATURE (°C)
01-Jan 01-Feb 01-Mar 01-Apr 01-May 01-Jun 01-Jul 01-Aug 01-Sep 01-Oct 01-Nov 01-Dec 01-Jan
2020

4. WATER TEMPERATARUE MONTHLY STATISTICS – BASELINE CONDITIONS

4.1. Upper Lillooet River

Table 2. Baseline monthly summary statistics at the upstream (ULL-USWQ1) and diversion (ULL-DVWQ) sites in the Upper Lillooet River from 2008 to 2013.

Year	Month	Water Temperature[1] (°C)							
		ULL-USWQ1				ULL-DVWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2008	Dec	0.7	0.0	2.8	0.6	-	-	-	-
2009	Jan	0.7	0.0	1.6	0.3	-	-	-	-
	Feb	0.9	0.0	3.0	0.6	-	-	-	-
	Mar	1.6	0.0	6.2	1.2	-	-	-	-
	Apr	3.4	0.5	8.1	1.8	-	-	-	-
	May	4.7	1.1	10.1	2.0	-	-	-	-
	Jun	6.2	3.6	10.5	1.7	-	-	-	-
	Jul	7.3	4.1	11.8	1.8	-	-	-	-
	Aug	6.4	3.9	9.9	1.5	-	-	-	-
	Sep	5.6	2.4	9.4	1.3	-	-	-	-
	Oct	3.6	0.6	6.9	1.4	-	-	-	-
	Nov	1.2	0.0	4.0	1.0	-	-	-	-
	Dec	0.4	0.0	1.2	0.3	-	-	-	-
2010	Jan	1.0	0.0	2.8	0.5	-	-	-	-
	Feb	1.8	0.0	4.1	0.7	-	-	-	-
	Mar	2.4	0.0	6.5	1.2	-	-	-	-
	Apr	3.2	0.3	8.0	1.6	-	-	-	-
	May	4.0	0.9	8.5	1.6	-	-	-	-
	Jun	4.9	2.8	8.9	1.4	-	-	-	-
	Jul	6.4	3.7	10.1	1.7	-	-	-	-
	Aug	6.4	3.7	10.1	1.5	-	-	-	-
	Sep	5.7	2.8	9.9	1.2	-	-	-	-
	Oct	4.5	1.7	7.4	1.0	-	-	-	-
	Nov	1.6	0.0	4.6	1.3	-	-	-	-
	Dec	0.7	0.0	1.8	0.4	1.2	0.0	2.4	0.6

[1] Statistics based on continuous data logged at 60 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

Table 2. Continued.

Year	Month	Water Temperature[1] (°C)							
		ULL-USWQ1				ULL-DVWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2011	Jan	0.9	0.0	2.5	0.6	1.3	0.0	3.1	0.9
	Feb	0.8	0.0	2.7	0.6	1.2	0.0	3.3	0.8
	Mar	1.9	0.0	5.7	1.2	-	-	-	-
	Apr	3.2	0.8	7.4	1.6	-	-	-	-
	May	3.1	1.1	7.3	1.2	-	-	-	-
	Jun	4.4	2.2	8.5	1.3	-	-	-	-
	Jul	5.8	3.3	10.0	1.4	-	-	-	-
	Aug	6.8	4.0	10.4	1.6	-	-	-	-
	Sep	6.4	3.9	10.1	1.4	-	-	-	-
	Oct	4.6	0.0	8.5	1.5	-	-	-	-
	Nov	0.9	0.0	3.5	0.7	-	-	-	-
	Dec	0.7	0.0	1.7	0.4	1.1	0.1	2.2	0.5
2012	Jan	0.6	0.0	2.2	0.5	1.1	0.0	2.8	0.7
	Feb	1.4	0.0	3.7	0.7	2.1	0.0	4.0	0.8
	Mar	1.8	0.0	5.7	1.2	2.5	0.1	5.1	1.1
	Apr	2.8	0.5	6.9	1.4	3.4	1.3	7.0	1.3
	May	3.7	1.5	7.7	1.5	4.3	1.9	8.5	1.7
	Jun	4.8	2.6	9.0	1.4	5.4	2.9	9.9	1.5
	Jul	6.2	3.5	10.0	1.6	6.6	3.9	10.4	1.6
	Aug	6.7	4.0	10.7	1.6	6.9	4.2	10.7	1.5
	Sep	6.0	2.7	9.9	1.6	6.2	3.1	9.9	1.5
	Oct	3.9	0.8	7.4	1.3	4.3	1.4	7.7	1.2
	Nov	1.8	0.0	5.6	1.4	2.3	0.0	5.9	1.4
	Dec	0.6	0.0	1.9	0.4	1.1	0.1	2.5	0.5
2013	Jan	0.6	0.0	1.7	0.5	1.0	0.0	2.5	0.7
	Feb	1.4	0.0	3.3	0.8	2.1	0.3	3.6	0.6
	Mar	2.1	0.0	7.0	1.5	2.8	0.4	6.2	1.2
	Apr	3.4	0.0	8.2	1.8	3.9	1.0	8.0	1.5
	May	4.4	1.1	9.5	1.8	-	-	-	-

[1] Statistics based on continuous data logged at 60 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

4.2. Boulder Creek

Table 3. Baseline monthly summary statistics at the upstream (BDR-USWQ) and diversion (BDR-DVWQ) sites in the Boulder Creek from 2008 to 2013.

Year	Month	Water Temperature[1] (°C)											
		NTH-USWQ1				BDR-USWQ				BDR-DVWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2008	Nov	-	-	-	-	-	-	-	-	-	-	-	-
	Dec	-	-	-	-	-	-	-	-	0.8	0.0	3.5	0.9
2009	Jan	-	-	-	-	-	-	-	-	1.1	0.0	2.0	0.6
	Feb	-	-	-	-	-	-	-	-	1.2	0.0	2.2	0.6
	Mar	-	-	-	-	-	-	-	-	1.1	0.0	2.3	0.6
	Apr	-	-	-	-	-	-	-	-	2.6	1.4	4.8	0.6
	May	-	-	-	-	-	-	-	-	4.1	2.4	8.5	1.1
	Jun	-	-	-	-	-	-	-	-	6.2	3.6	10.0	1.4
	Jul	-	-	-	-	-	-	-	-	7.9	4.6	11.4	1.6
	Aug	-	-	-	-	-	-	-	-	7.5	5.2	10.7	1.2
	Sep	-	-	-	-	-	-	-	-	6.7	3.3	10.0	1.2
	Oct	-	-	-	-	-	-	-	-	3.7	0.6	6.4	1.4
	Nov	-	-	-	-	-	-	-	-	1.6	0.0	4.0	0.9
	Dec	-	-	-	-	-	-	-	-	0.5	0.0	1.8	0.5
2010	Jan	-	-	-	-	-	-	-	-	1.4	0.0	2.7	0.6
	Feb	-	-	-	-	-	-	-	-	2.1	0.9	3.2	0.4
	Mar	-	-	-	-	-	-	-	-	2.3	0.0	4.2	0.8
	Apr	-	-	-	-	-	-	-	-	3.2	0.5	5.9	0.9
	May	-	-	-	-	2.8	0.8	5.6	0.9	4.2	1.8	7.1	1.0
	Jun	-	-	-	-	3.6	2.1	7.4	1.1	5.1	3.4	8.9	1.1
	Jul	-	-	-	-	5.5	2.9	9.4	1.6	7.0	4.3	11.0	1.6
	Aug	-	-	-	-	6.0	3.1	9.7	1.4	7.5	4.6	11.1	1.4
	Sep	5.4	2.4	8.1	1.1	5.2	2.2	9.2	1.2	6.7	3.5	10.7	1.2
	Oct	4.9	3.3	7.7	0.9	4.7	2.8	6.8	0.6	4.7	2.1	7.2	1.0
	Nov	1.7	0.0	4.7	1.3	2.0	0.0	4.3	1.4	1.8	0.0	4.8	1.5
	Dec	1.4	0.0	2.3	0.5	1.4	0.0	2.3	0.5	1.1	0.0	2.0	0.6

[1] Statistics based on continuous data logged at 60 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring

Table 3. Continued.

Year	Month	Water Temperature[1] (°C)											
		NTH-USWQ1				BDR-USWQ				BDR-DVWQ			
		Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
2011	Jan	1.4	0.0	2.7	0.7	1.4	0.0	2.7	0.7	0.8	0.0	2.4	0.8
	Feb	1.2	0.0	2.5	0.6	1.2	0.0	2.5	0.6	0.7	0.0	2.3	0.7
	Mar	2.0	0.1	3.7	0.5	2.0	0.1	3.7	0.5	1.7	0.0	3.2	0.6
	Apr	2.5	1.2	4.9	0.7	2.5	1.2	4.9	0.7	2.6	1.5	4.5	0.5
	May	2.8	1.8	4.8	0.5	2.7	1.3	5.2	0.7	3.3	2.4	6.1	0.6
	Jun	2.8	1.6	4.8	0.5	2.9	1.2	3.9	0.5	4.1	2.3	6.9	0.7
	Jul	3.7	2.5	6.2	0.7	4.1	2.2	7.6	1.0	5.5	3.3	9.0	1.1
	Aug	5.0	2.9	8.2	1.1	5.4	3.0	8.8	1.2	6.8	4.1	10.0	1.3
	Sep	5.6	3.3	8.5	1.1	5.2	3.0	8.4	1.1	6.6	3.9	10.1	1.3
	Oct	3.3	0.2	5.9	1.2	3.6	0.2	6.0	1.2	4.2	0.7	7.1	1.5
	Nov	0.9	0.0	2.5	0.6	0.9	0.0	2.5	0.6	0.8	0.0	2.5	0.7
	Dec	1.2	0.0	2.3	0.5	1.2	0.0	2.3	0.5	0.9	0.0	2.0	0.5
2012	Jan	1.0	0.0	2.3	0.7	1.0	0.0	2.3	0.7	0.6	0.0	1.7	0.5
	Feb	1.7	0.0	2.9	0.6	1.7	0.0	2.9	0.6	1.5	0.0	2.3	0.5
	Mar	1.7	0.0	3.4	0.7	1.7	0.0	3.4	0.7	1.5	0.0	2.6	0.5
	Apr	2.5	0.9	5.0	0.7	2.7	0.9	5.0	0.7	2.6	1.4	4.4	0.5
	May	2.8	1.8	4.9	0.6	3.0	0.7	4.7	0.9	3.7	2.3	6.2	0.7
	Jun	3.2	2.0	5.7	0.6	2.9	0.4	5.1	0.7	4.3	2.2	6.7	0.8
	Jul	4.4	2.8	7.4	1.0	4.7	1.2	8.4	1.3	6.3	3.2	9.8	1.4
	Aug	6.2	4.1	9.5	1.3	6.0	3.8	9.5	1.4	7.6	5.3	10.7	1.3
	Sep	6.1	2.6	9.6	1.3	5.9	2.6	9.2	1.3	7.0	3.6	10.2	1.3
	Oct	3.5	0.6	6.7	1.4	3.5	0.6	6.7	1.4	4.4	1.3	8.1	1.6
	Nov	1.8	0.1	4.7	1.1	1.8	0.1	4.4	1.1	2.3	0.5	5.4	1.3
	Dec	0.9	0.1	2.2	0.4	0.9	0.1	2.2	0.4	0.8	0.1	2.2	0.5
2013	Jan	1.0	0.0	2.2	0.6	1.0	0.0	2.2	0.6	0.7	0.0	1.9	0.5
	Feb	1.5	0.1	2.6	0.5	1.5	0.1	2.6	0.5	1.4	0.3	2.1	0.4
	Mar	1.6	0.1	3.4	0.6	1.6	0.1	3.4	0.6	1.7	0.2	3.5	0.7
	Apr	2.6	0.9	5.4	0.7	2.6	0.9	5.4	0.7	3.2	1.7	5.4	0.6
	May	-	-	-	-	-	-	-	-	4.5	1.8	7.3	1.1

[1] Statistics based on continuous data logged at 60 minute intervals. Statistics were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded

5. AIR TEMPERATURE MONTHLY STATISTICS – BASELINE

Table 4. Upper Lillooet River baseline (2010 to 2013) air temperature monthly data summary statistics.

Year	Month	Air Temperature[1] (°C)							
		ULL-USAT				ULL-DVAT			
		Avg	Min	Max	SD	Avg	Min	Max	SD
2010	Apr	2.6	-7.6	13.4	4.0	4.8	-4.7	17.1	4.0
	May	5.2	-3.3	17.0	4.8	8.9	-0.5	22.3	5.1
	Jun	10.4	0.5	24.4	5.5	12.2	4.4	26.0	4.8
	Jul	15.3	3.1	30.8	7.7	16.7	6.6	33.0	6.6
	Aug	13.9	0.8	31.2	7.0	15.3	5.1	32.8	5.8
	Sep	9.2	-1.4	24.2	4.4	10.6	2.1	25.8	3.7
	Oct	5.1	-3.6	16.0	3.3	6.8	-0.7	19.1	2.9
	Nov	-3.3	-19.9	5.6	6.0	-1.3	-16.7	9.3	5.3
	Dec	-4.9	-22.1	0.6	5.9	-2.7	-14.5	1.0	3.8
2011	Jan	-5.9	-23.8	2.0	6.4	-3.5	-15.6	2.8	4.4
	Feb	-5.8	-20.6	1.6	5.1	-3.7	-19.7	4.8	4.6
	Mar	-	-	-	-	0.5	-8.9	9.8	2.7
	Apr	1.3	-6.0	15.5	3.7	2.7	-3.3	13.8	3.2
	May	3.7	-3.5	15.1	3.8	-	-	-	-
	Jun	7.7	-0.5	21.2	5.4	-	-	-	-
	Jul	11.8	0.8	27.5	5.3	-	-	-	-
	Aug	13.1	1.9	26.5	6.5	-	-	-	-
	Sep	10.1	-0.2	27.7	5.7	-	-	-	-
	Oct	3.4	-4.5	12.6	3.5	-	-	-	-
	Nov	-3.5	-19.5	3.6	4.1	-	-	-	-
	Dec	-6.2	-17.6	0.1	4.9	-	-	-	-
2012	Jan	-5.6	-25.0	1.3	6.5	-	-	-	-
	Feb	-2.2	-10.3	0.6	2.5	-	-	-	-
	Mar	-1.4	-13.2	9.8	3.3	-	-	-	-
	Apr	2.3	-6.5	12.3	3.2	-	-	-	-
	May	5.0	-2.8	17.7	4.8	8.2	-0.5	23.4	5.2
	Jun	9.4	-0.2	24.1	5.2	11.3	3.0	24.9	4.3
	Jul	14.4	2.6	30.5	6.8	14.8	6.8	32.1	5.8
	Aug	14.5	2.3	32.3	7.2	15.6	6.8	32.3	5.4
	Sep	10.3	-1.1	27.8	6.4	12.8	2.7	27.6	4.7
	Oct	4.0	-4.6	17.8	4.1	6.0	-2.0	19.4	3.9
	Nov	-0.4	-10.7	7.6	3.9	1.2	-5.7	8.6	3.1
	Dec	-5.4	-16.4	1.5	3.9	-2.9	-9.0	2.4	2.5
2013	Jan	-7.8	-21.5	1.0	6.2	-4.4	-14.2	2.3	4.2
	Feb	-2.1	-13.0	2.6	2.9	0.1	-6.3	7.7	1.8
	Mar	-0.2	-10.4	11.2	3.7	1.6	-5.9	11.5	3.0
	Apr	2.9	-5.2	12.6	3.6	4.0	-2.2	15.0	3.2

[1] Statistics based on data logged at 30-minute intervals and were not generated for months with less than three weeks of data. Minimum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in blue. Maximum monthly average and instantaneous temperatures recorded at each site during the baseline monitoring period are shaded in red.

Table 5. Boulder Creek baseline (2010 to 2013) air temperature monthly data summary statistics.

Year	Month	Air Temperature[1] (°C)			
		BDR-DVAT			
		Avg	Min	Max	SD
2010	May	8.8	0.1	22.8	5.0
	Jun	11.7	4.4	26.9	5.0
	Jul	16.5	6.1	34.4	7.1
	Aug	15.4	4.9	32.9	6.1
	Sep	10.2	1.9	26.7	3.6
	Oct	6.5	-0.8	15.2	2.5
	Nov	-1.1	-15.4	7.2	5.0
	Dec	-2.6	-13.5	0.9	3.5
2011	Jan	-3.5	-14.4	1.9	4.1
	Feb	-3.3	-14.0	2.4	3.5
	Mar	0.4	-8.4	12.1	2.8
	Apr	2.5	-2.7	13.1	3.1
	May	6.2	-0.3	22.7	4.3
	Jun	10.8	4.0	26.1	4.9
	Jul	11.9	4.2	28.0	4.8
	Aug	13.9	5.5	28.2	5.4
	Sep	11.4	3.3	27.3	4.6
	Oct	4.9	-1.2	12.7	3.0
	Nov	-1.4	-12.4	3.1	2.9
	Dec	-2.6	-9.6	1.2	2.5
2012	Jan	-3.8	-20.4	1.8	5.6
	Feb	-0.6	-12.8	3.9	2.3
	Mar	-0.1	-8.3	9.3	2.4
	Apr	3.1	-2.9	14.6	2.7
	May	8.5	-0.1	24.3	5.2
	Jun	10.5	3.0	25.2	4.5
	Jul	14.1	5.3	32.4	6.3
	Aug	15.4	6.5	32.6	5.9
	Sep	12.4	2.1	28.2	4.6
	Oct	5.7	-1.8	16.2	3.4
	Nov	1.0	-6.0	8.5	3.0
	Dec	-2.9	-8.8	1.8	2.4
2013	Jan	-4.2	-14.2	1.7	3.9
	Feb	-0.1	-6.4	4.5	1.5
	Mar	1.2	-5.9	10.8	2.5
	Apr	4.6	-2.0	19.6	3.7
	May	-	-	-	-

[1] Statistics based on hourly (60-minute) data and were not generated for months with less than three weeks of data.

6. DAILY WATER TEMPERATURE SUMMARY FIGURES- BASELINE

Figure 23. Daily mean water temperature collected during baseline monitoring in the Upper Lillooet River (2008 to 2013).

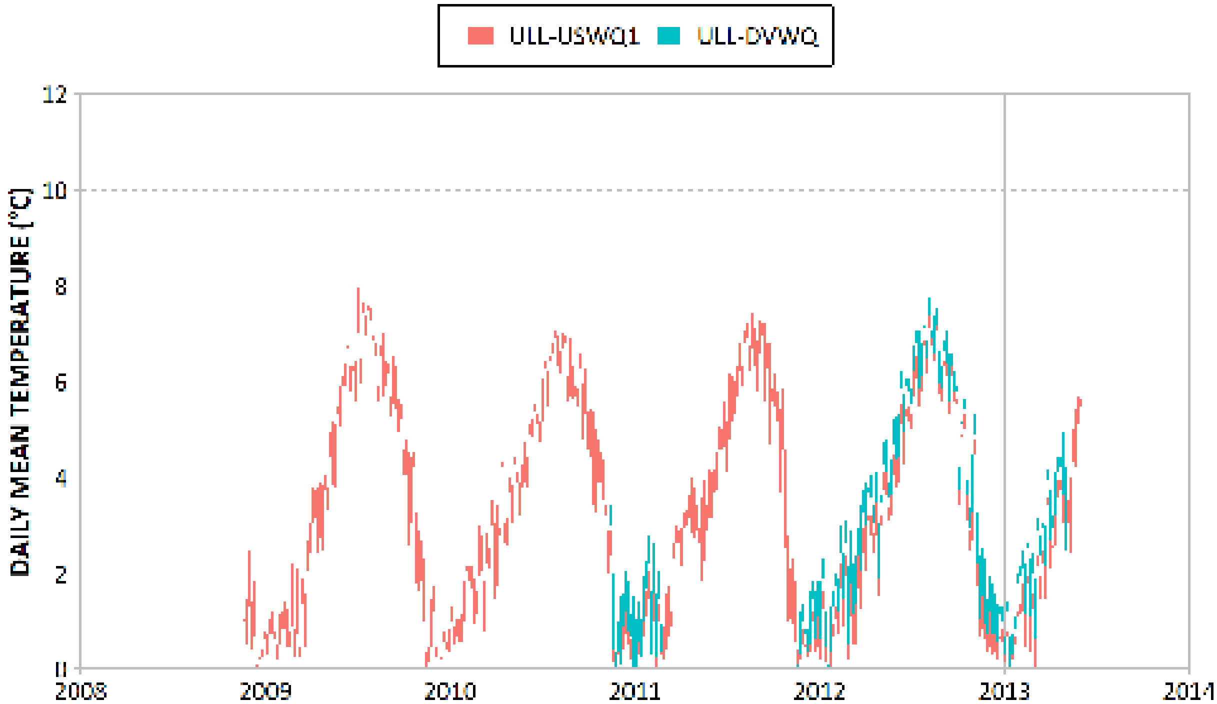
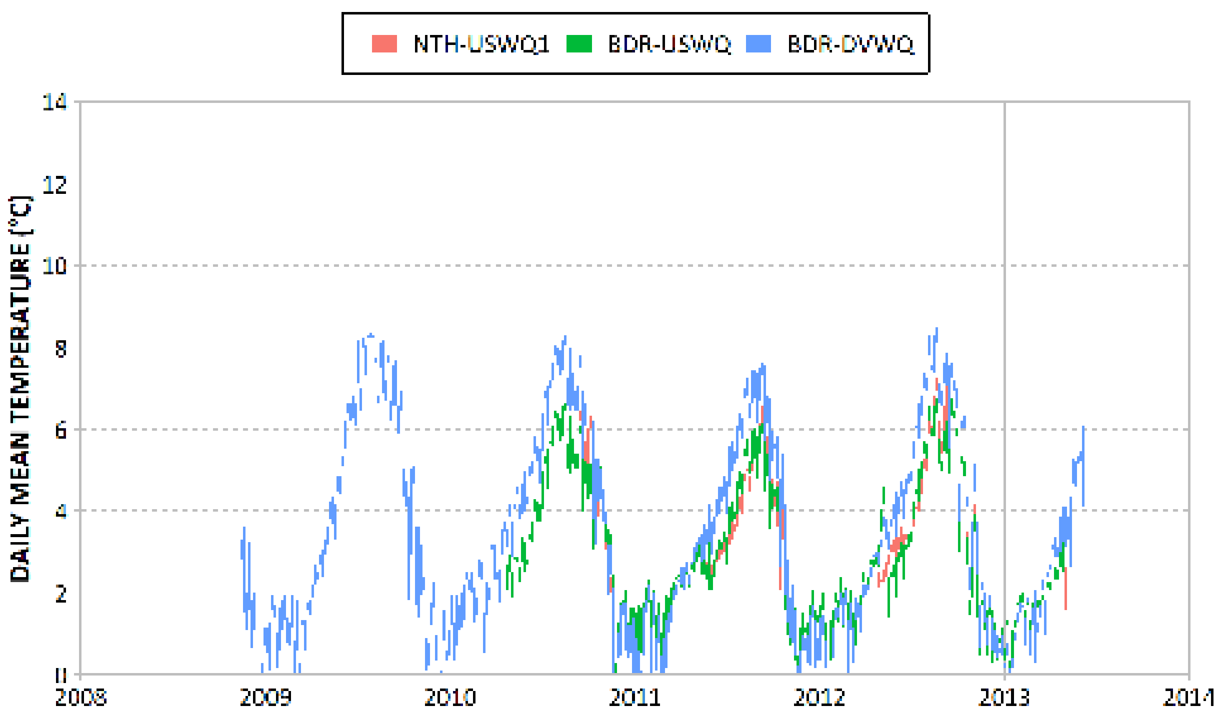


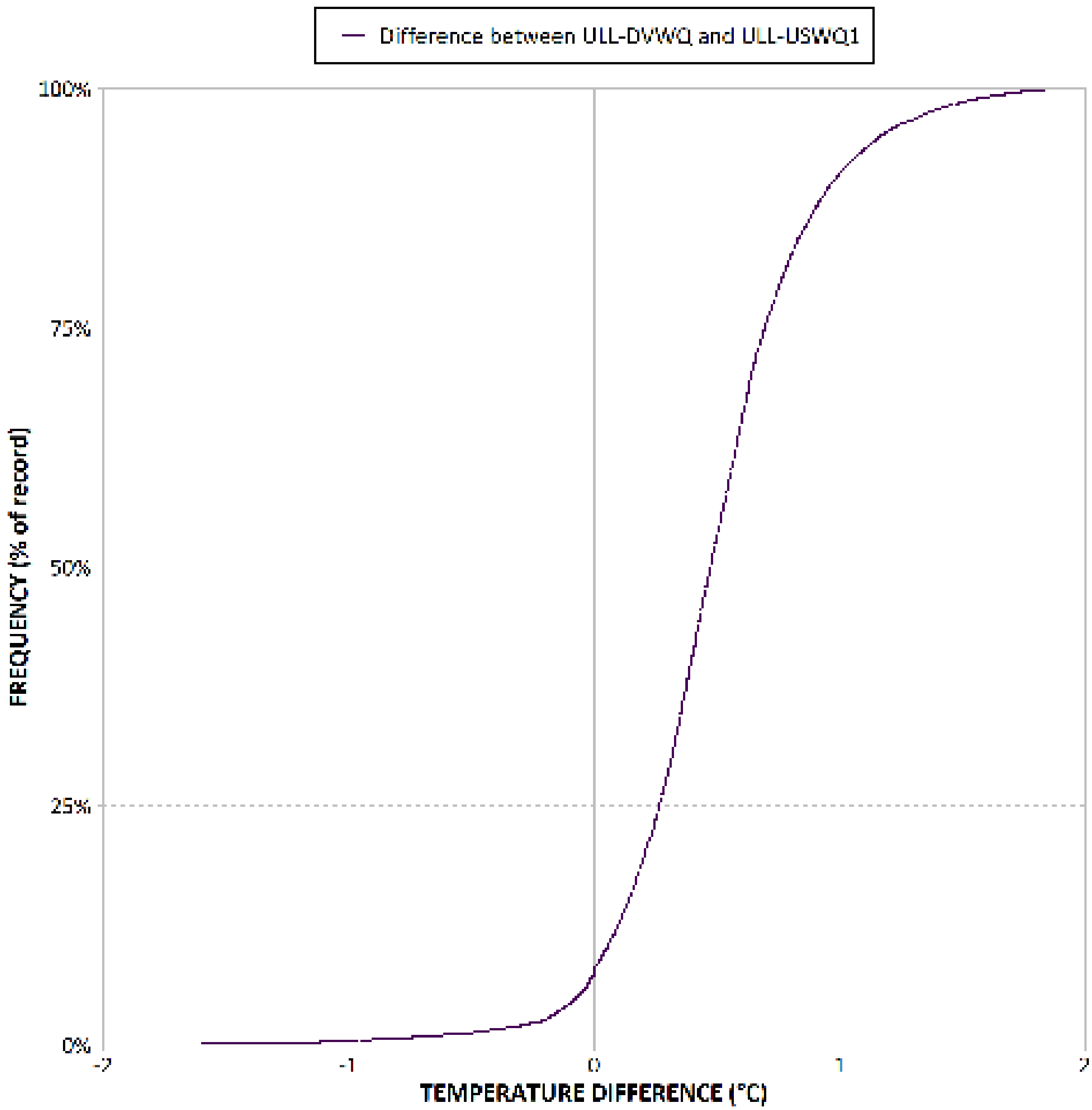
Figure 24. Daily mean water temperature collected during baseline monitoring in Boulder Creek and North Creek (2008 to 2013).



7. INTER-STATION COMPARISON – BASELINE CONDITIONS

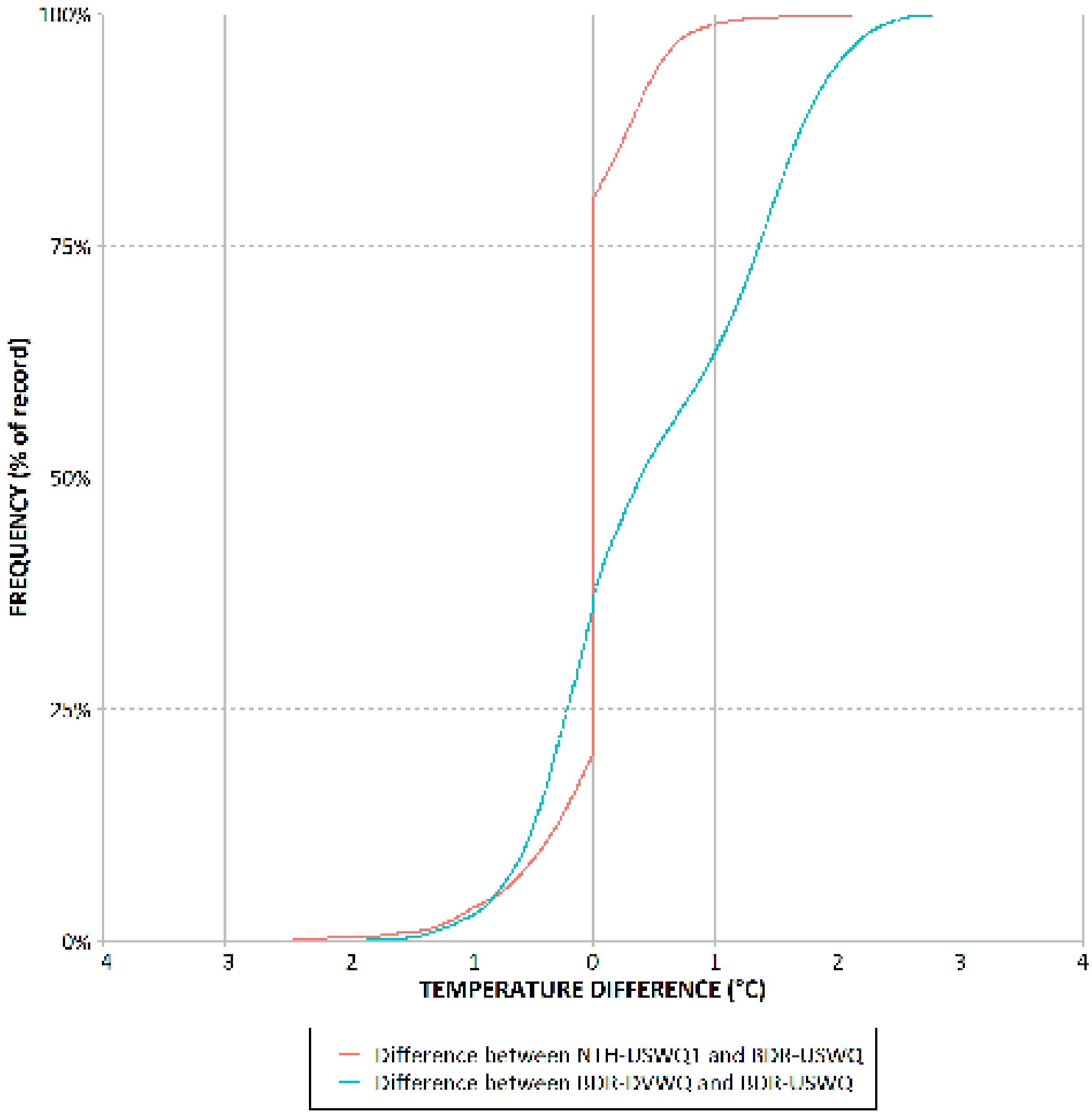
7.1. Upper Lillooet River

Figure 25. Cumulative frequency distribution of differences in baseline instantaneous water temperature between the diversion (ULL-DVWQ) and upstream control (ULL-USWQ1) site in the Upper Lillooet River.



7.2. Boulder Creek

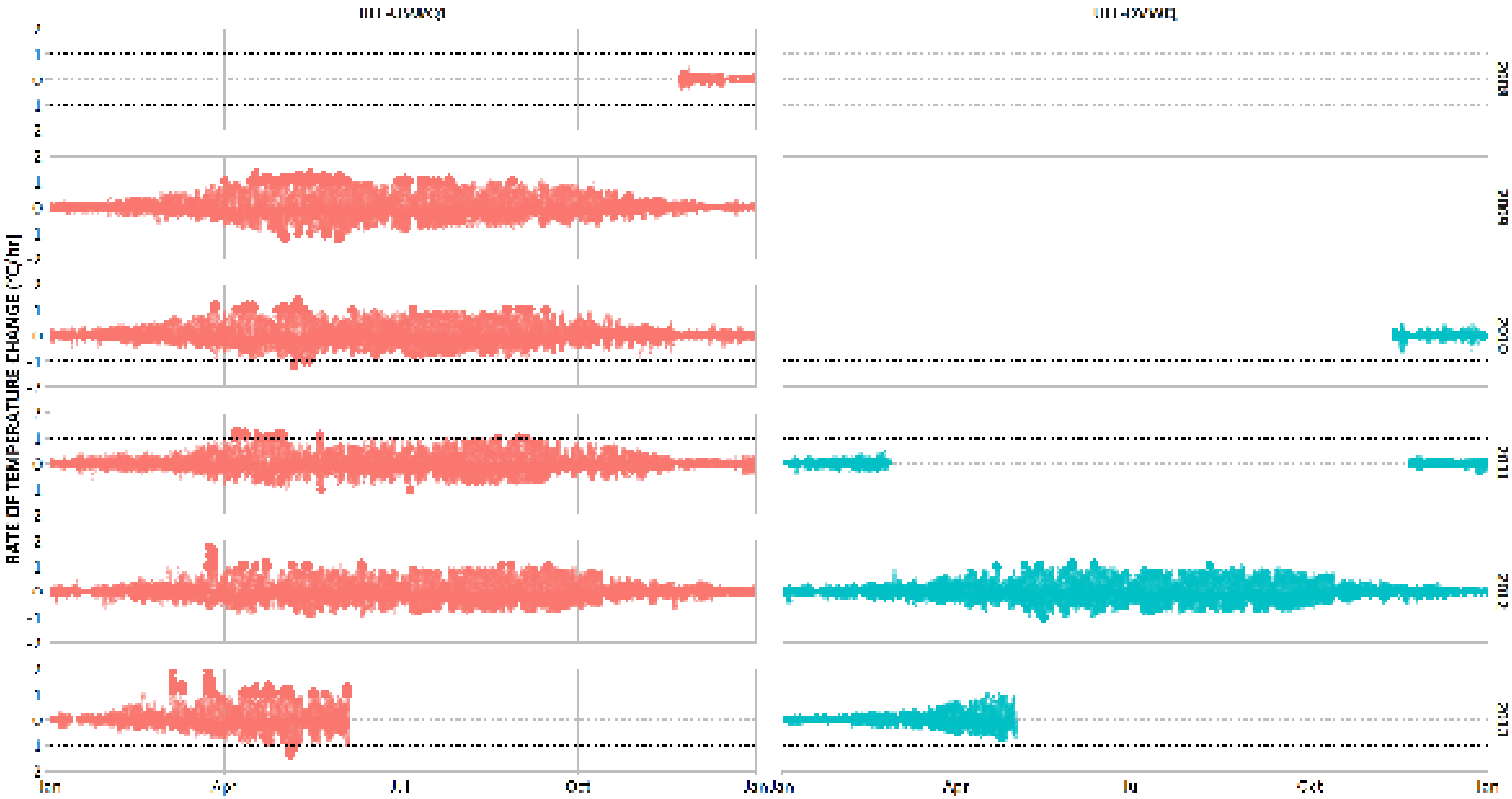
Figure 26. Cumulative frequency distribution of differences in baseline instantaneous water temperature between the upstream control site on Boulder Creek (BDR-USWQ) and the North Creek upstream site (NTH-USWQ1) and the Boulder Creek diversion site (BDR-DVWQ).



8. HOURLY RATE OF WATER TEMPERATURE CHANGE

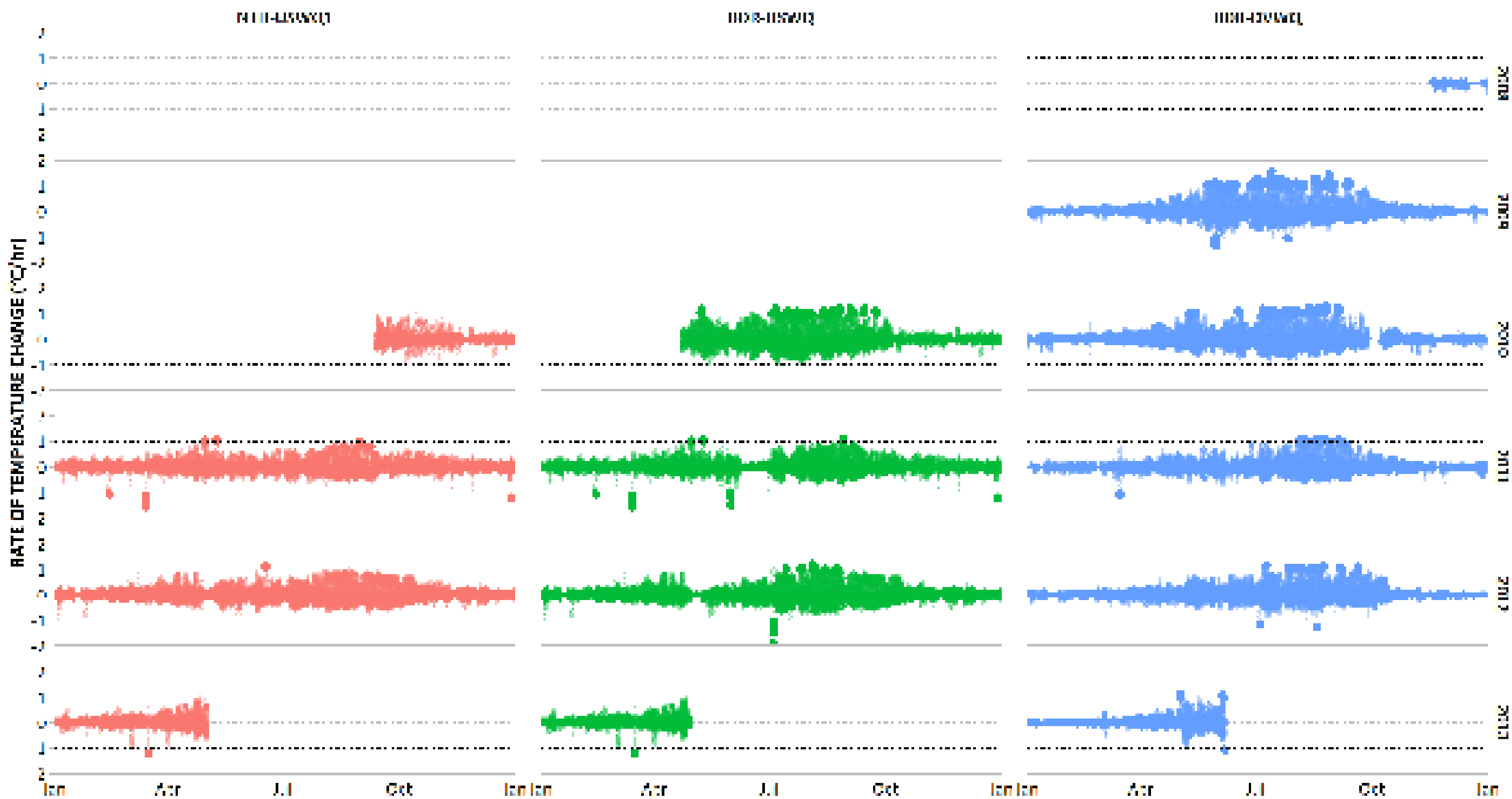
8.1. Upper Lillooet River

Figure 27. Baseline hourly rate of change in water temperature at the upstream (ULL-USWQ1) and diversion (ULL-DVWQ) water temperature monitoring sites from 2008 to 2013.



8.1. Boulder Creek

Figure 28. Baseline hourly rate of change in water temperature at the upstream site in nearby North Creek (NTH-USWQ1), and upstream (BDR-USWQ) and diversion (BDR-DVWQ) water temperature monitoring sites in Boulder Creek from 2008 to 2013.



REFERENCES

MOE (BC Ministry of Environment and Climate Change). 2019. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. Available online at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/wqg_summary_aquaticlife_wildlife_agri.pdf. Accessed on April 20, 2021.

Oliver, G.G. and L.E. Fidler. 2001. Towards a water quality guideline for temperature in the Province of British Columbia. Prepared for Ministry of Environment, Lands and Parks, Water Management Branch, Water Quality Section, Victoria, B.C. Prepared by Aspen Applied Sciences Ltd., Cranbrook, B.C., 53 pp + appnds. Available online at: https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/waterquality/water-quality-guidelines/approved-wqgs/temperature-tech.pdf. Accessed on April 20, 2021.

Appendix E. Upper Lillooet Hydro Project Standard Operating Procedure: Harlequin Duck Spot Check Protocol

UPPER LILLOOET HYDRO PROJECT

STANDARD OPERATING PROCEDURE

Harlequin Duck Spot Check Protocol

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Harlequin Duck spot checks are a requirement of the Upper Lillooet Hydro Project (the Project) Operational Environmental Monitoring Plan. Spot checks are intended to record the presence or absence of Harlequin Ducks and any evidence of successful breeding in the Project area. Spot checks are scans that are conducted from specific vantage points and at specific times during the Harlequin Duck breeding season. It is important to record some information every time a spot check is conducted, even if no Harlequin Ducks are observed. Timing, locations, and methods of spot checks should be consistent so that annual results are comparable.

2. SPOT CHECK METHODS

Specific methods should be followed for each spot check to keep data comparable. The methods to be followed are:

- Always conduct spot checks from the same vantage point for each Location ID (Table 1).
- Conduct a thorough scan of the visible area from the vantage point using binoculars and/or a spotting scope. Note that female Harlequin Ducks and juveniles are much less conspicuous than males and extra effort is required to spot them. Pay close attention to riparian areas where ducks may be partly concealed in overhanging riparian vegetation and scan exposed instream rocks where birds may haul out. Due to their brownish colour, females that are hauled out on rocks may blend in and can be difficult to see. Foraging birds may be diving in which case they will be underwater part of the time thus several scans of the water are required.

2.1. Locations

Spot checks will be conducted at the intake and powerhouse to focus on the locations where Harlequin Ducks were observed during baseline studies. Harlequin Ducks were also observed approximately 600 m upstream of the powerhouse, incidentally during baseline data collection for other monitoring components; however, this area is not visible from an easily accessible vantage point so observations in this area will continue to be collected incidentally when Ecofish crews download the logger and conduct potential fish stranding searches in this area. Spot checks should always take place from the same vantage points, and any deviation in methodology must be recorded. Each location has a label (ID) that should be entered into the "Location" field of the datasheet (Table 2). Each Location ID is associated with UTM coordinates. Spot check locations were flagged in May 2018 and are described below.

- Harlequin Ducks will be monitored from one of two vantage points at the intake to capture potential activity in the headpond as well as slightly upstream and downstream (ULL-HADU01a, ULL-HADU01b; Table 1, Figure 2). The vantage point at ULL-HADU01a is accessible early in the season when snow prohibits safe access to potential vantage points closer to the river. The vantage point at ULL-HADU01b is only accessible when snow does not prevent safe access. When monitoring from ULL-HADU01b it is recommended that the surveyor walk out onto the intake for the best view.

- Harlequin Ducks will be monitored from a vantage point at the powerhouse to capture potential activity near the tailrace as well as slightly upstream and downstream (NST-HADU02; Table 1, Figure 3).

Table 1. Harlequin Duck monitoring points at the intake.

Infrastructure	Location ID	UTM Coordinates (Zone 10U)		Description
		Easting	Northing	
Intake	ULL-HADU01a	466156	5614170	Above the road at the intake. To be used when snow prevents access to ULL-HADU01b.
	ULL-HADU01b	466105	5614110	Adjacent to the intake fence. To be used when accessible. To get the best view, walk out onto the intake from here when safe.
Powerhouse	ULL-HADU02	468416	5611634	On the boulders immediately downstream of the powerhouse.

Figure 1. View of ULL-HADU01a on April 30, 2018.

Figure 2. View of ULL-HADU01b on May 31, 2018.

Figure 3. View of ULL-HADU02 on May 3, 2018.

2.2. Timing

There are two time periods that are most valuable for conducting spot checks. These are:

1) the pre-incubation period (month of May), when Harlequin Duck pairs are on the river but before the female begins to incubate. Once incubation begins the male leaves and the female becomes secretive; and
2) the brood-rearing period (late July to late August) after ducklings hatch, adult males have departed, and the female is rearing her brood. At this time family groups, as well as females that have not bred successfully, can be seen on the river.

Spot checks will be scheduled to occur during these two time periods. Each time a spot check is conducted, the date and time will be recorded on the datasheet (Table 2).

2.2.1. Pre-incubation (May)

- Three spot checks will be conducted at each location during May; spot checks should be at least five days apart.

2.2.2. Brood-rearing (August 1 – August 30)

- Three spot checks will be conducted at each location from August 1 through to August 30; spot checks should be at least five days apart, with two of the spot checks occurring between August 1 and August 15.

2.3. What to Record

All required information listed below must be recorded on the Harlequin Duck spot check survey datasheet (Table 2) every time a spot check is conducted, regardless of what is seen. Please review the **Harlequin Duck Fact Sheet** for important information on identification and species biology.

Information that must be recorded includes:

- Date of the spot check.
- Time of the spot check.
- Initials of the person(s) conducting the spot check.
- Location of the spot check (specify the Location ID).
- The total number of Harlequin Ducks seen, including "0" if none were seen (enter in "Total Number" field in the datasheet). The numbers of each sex/age category should be entered into the appropriate fields of the datasheet. Including the total numbers of:
  - adult males;
  - adult female-like birds (note that juveniles are hard to distinguish from adult females and are therefore included in this group);
  - ducklings (smaller than adults early in the brood-rearing period); and
  - individuals of unknown sex (cannot be identified as adult males or adult female-like birds, and are not ducklings that can be distinguished by size).

- Record comments in the "Comments" column of the datasheet for every spot check:
    - if no Harlequin Ducks are seen, state this in words;
    - pair(s) (male and female close together) or family group (for example: a female with three female-like birds that may be juveniles based on their proximity and synchronous behaviour);
    - other species (e.g., American Dippers, mergansers, Barrow's Goldeneye); and
    - visibility limitations (e.g., due to poor weather, or if the water level in the river is unusually high or low.
- Take photos of all Harlequin Ducks and other wildlife observaed and record photo numbers in the appropriate field of the data sheet.

2.4. Equipment Required

Equipment required for spot check includes:

- Clipboard with datasheets and Harlequin Duck Fact Sheet.
- Binoculars and/or spotting scope.
- Digital Camera.

Table 2. Harlequin Duck spot check datasheet.

Ecofish Research Ltd.
Suite F, 450 8th Street,
Courtenay, B.C.
V9N 1N5

Date	Time	Location[1]	Total Number[2]	Number of Adult Males	Number of female-like[3]	Number of Ducklings	Number of Unknown Sex	Comments (describe behaviour and other observations of interest such as weather conditions and other species observed)[4]	Photo Number	Observer Initials

[1] Location ID as described in Spot Check Protocols. If location is different, note at UTM or mark on a map.

[2] Indicate zero if no Harlequin Ducks are seen.

[3] Includes adult females and large juveniles that look like adult females.

[4] Describe behaviour (e.g., feeding, preening, hauled out on rocks, flying upstream or downstream) and wether birds are behaving as a group (e.g., "feeding together; appear to be a pair"); note any other observations of interest such as other riverine species (e.g., American Dippers); any limitations on survey methods (e.g., poor visibility due to poor weather) or unusual conditions (e.g., water levels very high). Include some comments for every spot check.

3. HARLEQUIN DUCK FACT SHEET

3.1. Physical Description

Male

- Dark from a distance, white streaks and colourful patches can be seen closer up;
- Slate blue plumage and belly, chestnut sides and streaks of white on the head and body; and
- Crown has a black stripe with a larger white patch in front of the eye and a small white ear patch.

Female

- Plain brownish-grey with lighter underside;
- The face in front of the eye is light in colour and has distinctive white ear patch; and
- Roughly half the size of a Mallard duck.

Immature

- After hatching, ducklings can be distinguished by their small size relative to the adult female;
- When larger but while still on the breeding stream, juveniles of both sexes resemble the adult female; and
- Young males begin to look like adults in fall, but they do not gain full adult plumage until the next summer.

3.2. Life History

- Arrive on breeding streams shortly after spring break-up;
- Females lay 3-10 eggs that hatch after approximately one month;

- Males leave the breeding stream once the female begins to incubate;
- Females and their young return to the coast together in late September; and
- Individuals often return to the same breeding site year after year.

3.3. Habitat

- Spend their winters at the coast and breed near fast-flowing rivers and streams;
- Require streams with adequate amounts of aquatic invertebrates for consumption;
- Riparian vegetation is an important component of their habitat requirements;
- Usually nest under shrubs within 30 m of the stream; and
- Ducklings require overhanging vegetation along stream banks for protection from predators.

4. OTHER WATERFOWL COMMON IN HEADPONDS

4.1. Barrow's Goldeneye and Common Goldeneye

Barrow's Goldeneye and Common Goldeneye are usually slightly larger than Harlequin Ducks.

Female

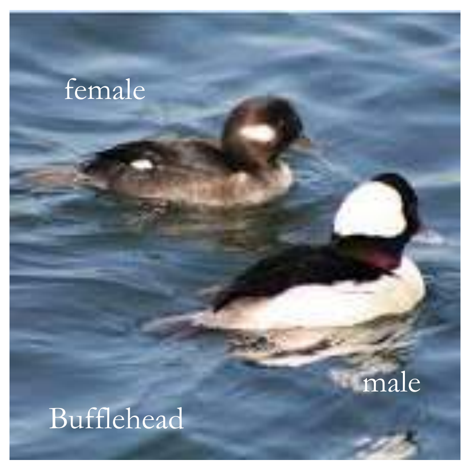
- Can be distinguished from Harlequin Ducks by their orange bills and dark grey bodies which contrast with their brown heads. (Harlequin Duck females and juveniles have uniformly brown bodies and heads.)

Male

- Can be distinguished from Harlequin Ducks by their black and with bodies, and dark green heads with a single white spot near the bill.

4.2. Bufflehead

Buffleheads are smaller than Harlequin Ducks.



Female

- Can be distinguished from Harlequin Ducks by their single cheek spot and their smaller size. (Harlequin Duck females and juveniles have a large pale patch near their bill in addition to a small white spot further back on their cheek.)

Male

- Can be distinguished from Harlequin Ducks by their wedge shaped white patch from their eyes to the back of their head, as well as their solid black back and solid white sides.

4.3. Common Merganser

Common Mergansers are larger than Harlequin Ducks.

Female

- Can be distinguished from Harlequin Ducks by their reddish head and bill, greyish body plumage, white chest and their larger size.

Male

- Can be distinguished from Harlequin Ducks by their red bill, dark green head, black and grey back, white body and chest plumage and their larger size.

Appendix F. Riparian Revegetation Permanent Monitoring Site Photographs

LIST OF FIGURES

Figure 1. View north through BDR-PRM01 plot centre from 3 m south of plot centre on September 6, 2018.

Figure 2. View north through BDR-PRM01 plot centre from 3 m south of plot centre on September 02, 2020.

Figure 3. View north through ULL-PRM01 plot centre from 3 m south of plot centre on September 7, 2018.

Figure 4. View north through ULL-PRM01 plot centre from 3 m south of plot centre on September 1, 2020.

Figure 5. View north through ULL-PRM02 plot centre from 3 m south of plot centre on September 7, 2018.

Figure 6. View north through ULL-PRM02 plot centre from 3 m south of plot centre on September 01, 2020.

Figure 7. View north through ULL-PRM03 plot centre from 3 m south of plot centre on September 6, 2018.

Figure 8. View north through ULL-PRM03 plot centre from 3 m south of plot centre on September 1, 2020.

Figure 9. View north through ULL-PRM04 plot centre from 3 m south of plot centre on September 7, 2018.

Figure 10. View north through ULL-PRM04 plot centre from 3 m south of plot centre on September 01, 2020.

Figure 11. View north through ULL-PRM05 plot centre from 3 m south of plot centre on September 7, 2018.

Figure 12. View north through ULL-PRM05 plot centre from 3 m south of plot centre on September 01, 2020.

Figure 13. View north through ULL-PRM06 plot centre from 3 m south of plot centre on September 7, 2018.

Figure 14. View north through ULL-PRM06 plot centre from 3 m south of plot centre on September 01, 2020.

Figure 15. View north through ULL-PRM07 plot centre from 3 m south of plot centre on September 6, 2018.

Figure 16. View north through ULL-PRM07 plot centre from 3 m south of plot centre on September 02, 2020.

Figure 17. View north through ULL-PRM08 plot centre from 3 m south of plot centre on September 6, 2018.

Figure 18. View north through ULL-PRM08 plot centre from 3 m south of plot centre on September 2, 2020.

Figure 19. View north through ULL-PRM09 plot centre from 3 m south of plot centre on September 6, 2018.

Figure 20. View north through ULL-PRM09 plot centre from 3 m south of plot centre on September 02, 2020.

Figure 21. View north through ULL-PRM10 plot centre from 3 m south of plot centre on September 6, 2018.

Figure 22. View north through ULL-PRM10 plot centre from 3 m south of plot centre on September 02, 2020.

Figure 23. View north through ULL-PRM11 plot centre from 3 m south of plot centre on September 6, 2018.

Figure 24. View north through ULL-PRM11 plot centre from 3 m south of plot centre on September 2, 2020.

Appendix G. Riparian Revegetation Site Overview Photographs

TABLE OF CONTENTS

LIST OF FIGURES

1. BDR-PRM01

Figure 1. Representative site photo taken at 160° from BDR-PRM01 on September 6, 2018.

Figure 2. Representative site photo taken 180° from BDR-PRM01 plot centre on September 6, 2018.

Figure 3. Representative site photo taken at 160° from BDR-PRM01 on September 1, 2020.

Figure 4. Representative site photo taken 180° from BDR-PRM01 plot centre on September 1, 2020.

2. ULL-PRM01

Figure 5. Representative site photo taken at 154° from ULL-PRM01 on September 7, 2018.

Figure 6. Representative site photo taken 270° from ULL-PRM01 plot centre on September 7, 2018.

Figure 7. Representative site photo taken at 154° from ULL-PRM01 on September 1, 2020.

Figure 8. Representative site photo taken 270° from ULL-PRM01 plot centre on September 1, 2020.

3. ULL-PRM02

Figure 9. Representative site photo taken at 64° from ULL-PRM02 on September 7, 2018.

Figure 10. Looking upstream at the dam from ULL-PRM02 on September 7, 2018.

Figure 11. Representative site photo taken at 64° from ULL-PRM02 on September 1, 2020.

Figure 12. Looking upstream at the dam from ULL-PRM02 on September 1, 2020.

4. ULL-PRM03

Figure 13. Representative site photo taken at 144° from ULL-PRM03 on September 6, 2018.

Figure 14. Representative site photo taken 270° from ULL-PRM03 plot centre on September 6, 2018.

Figure 15. Representative site photo taken at 144° from ULL-PRM03 on September 1, 2020.

Figure 16. Representative site photo taken 270° from ULL-PRM03 plot centre on September 1, 2020.

5. ULL-PRM04

Figure 17. Representative site photo taken at 164° from ULL-PRM04 on September 7, 2018.

Figure 18. Representative site photo taken 90° from ULL-PRM04 plot centre on September 7, 2018.

Figure 19. Representative site photo taken at 164° from ULL-PRM04 on September 1, 2020.

Figure 20. Representative site photo taken 90° from ULL-PRM04 plot centre on September 1, 2020.

6. ULL-PRM05

Figure 21. Representative site photo taken at 312° from ULL-PRM05 on September 7, 2018.

Figure 22. Representative site photo taken 180° from ULL-PRM05 plot centre on September 7, 2018.

Figure 23. Representative site photo taken at 312° from ULL-PRM05 on September 1, 2020.

Figure 24. Representative site photo taken 180° from ULL-PRM05 plot centre on September 1, 2020.

7. ULL-PRM06

Figure 25. Representative site photo taken at 104° from ULL-PRM06 on September 6, 2018.

Figure 26. Representative site photo taken 90° from ULL-PRM06 plot centre on September 6, 2018.

Figure 27. Representative site photo taken at 104° from ULL-PRM06 on September 1, 2020.

Figure 28. Representative site photo taken 90° from ULL-PRM06 plot centre on September 1, 2020.

8. ULL-PRM07

Figure 29. Representative site photo taken at 270° from ULL-PRM07 on September 6, 2018.

Figure 30. Representative site photo taken 90° from ULL-PRM07 plot centre on September 6, 2018.

Figure 31. Representative site photo taken at 270° from ULL-PRM07 on September 2, 2020.

Figure 32. Representative site photo taken 90° from ULL-PRM07 plot centre on September 2, 2020.

9. ULL-PRM08

Figure 33. Representative site photo taken at 222° from ULL-PRM08 on September 6, 2018.

Figure 34. Representative site photo taken 90° from ULL-PRM08 plot centre on September 6, 2018.

Figure 35. Representative site photo taken at 222° from ULL-PRM08 on September 2, 2020.

Figure 36. Representative site photo taken 90° from ULL-PRM08 plot centre on September 2, 2020.

10. ULL-PRM09

Figure 37. Representative site photo taken at 222° from ULL-PRM09 on September 6, 2018

Figure 38. Representative site photo taken from edge of stream at ULL-PRM09 on September 6, 2018.

Figure 39. Representative site photo taken at 222° from ULL-PRM09 on September 2, 2020.

Figure 40. Representative site photo taken from edge of stream at ULL-PRM09 on September 2, 2020.

11. ULL-PRM10

Figure 41. Representative site photo taken at 86° from ULL-PRM10 on September 6, 2018.

Figure 42. Representative site photo taken 180° from ULL-PRM10 plot centre on September 6, 2018.

Figure 43. Representative site photo taken at 86° from ULL-PRM10 on September 2, 2020.

Figure 44. Representative site photo taken 180° from ULL-PRM10 plot centre on September 2, 2020.

12. ULL-PRM11

Figure 45. Representative site photo taken at 88° from ULL-PRM11 on September 6, 2018.

Figure 46. Representative site photo taken 270° from ULL-PRM11 plot centre on September 6, 2018.

Figure 47. Representative site photo taken at 88° from ULL-PRM11 on September 2, 2020.

Figure 48. Representative site photo taken 270° from ULL-PRM11 plot centre on September 2, 2020.

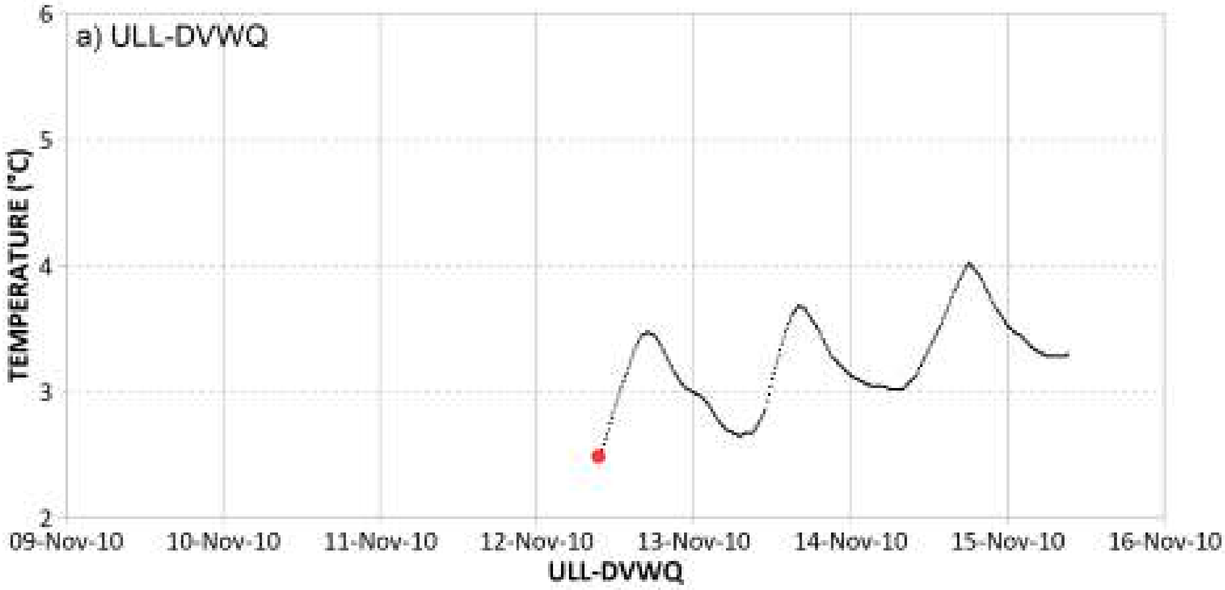
Appendix H. Water Temperature QA/QC Figures, 2020

LIST OF FIGURES

1. QA/QC SPOT TEMPERATURE MEASUREMENTS

1.1. Upper Lillooet River

Figure 1. Spot temperature QA/QC plots for ULL-DVWQ and ULL-DVWQ01.



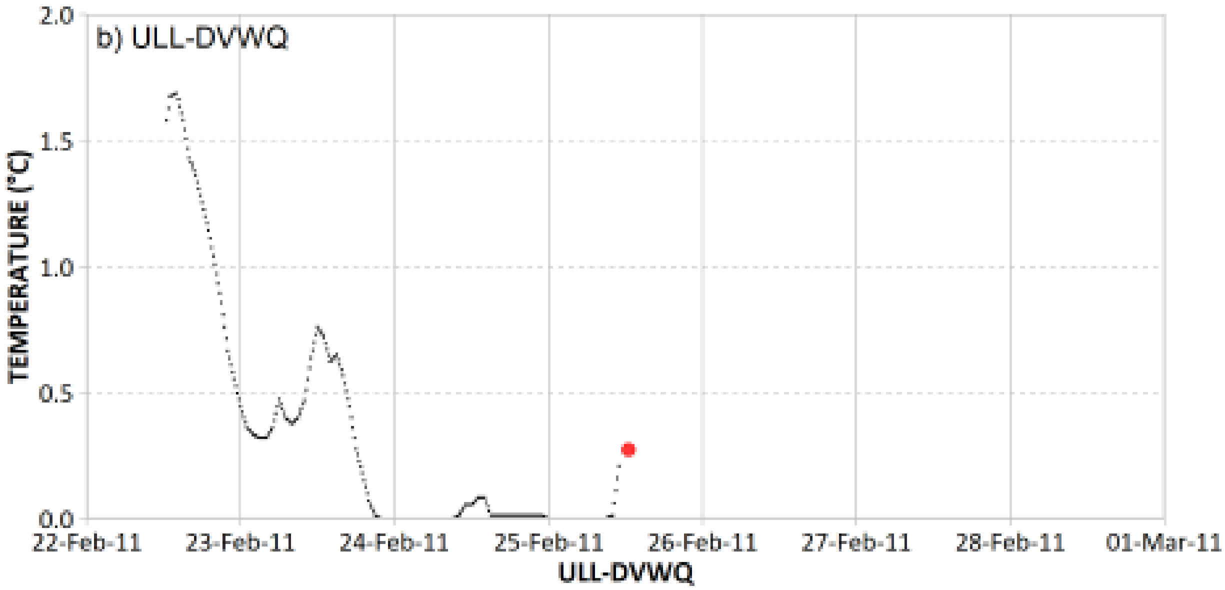
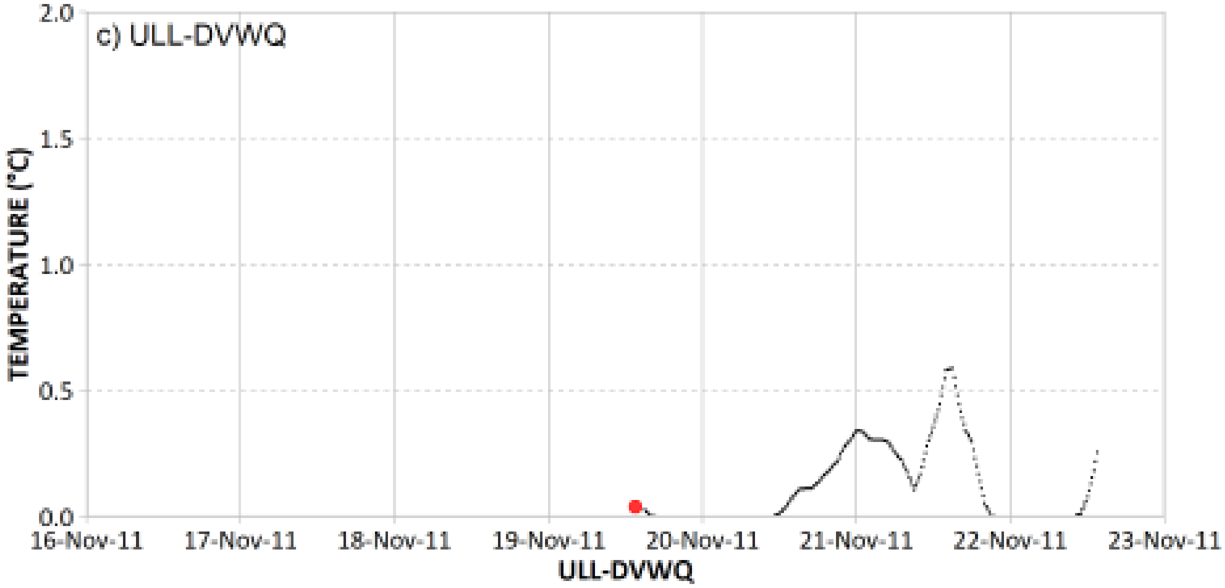


Figure 1. Continued.



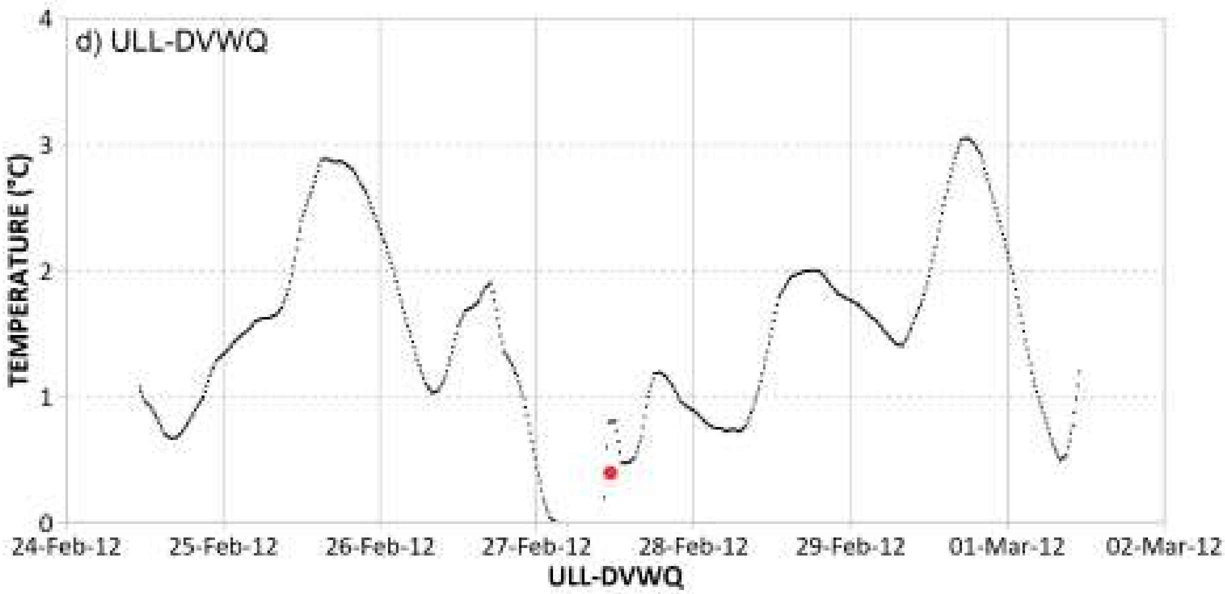
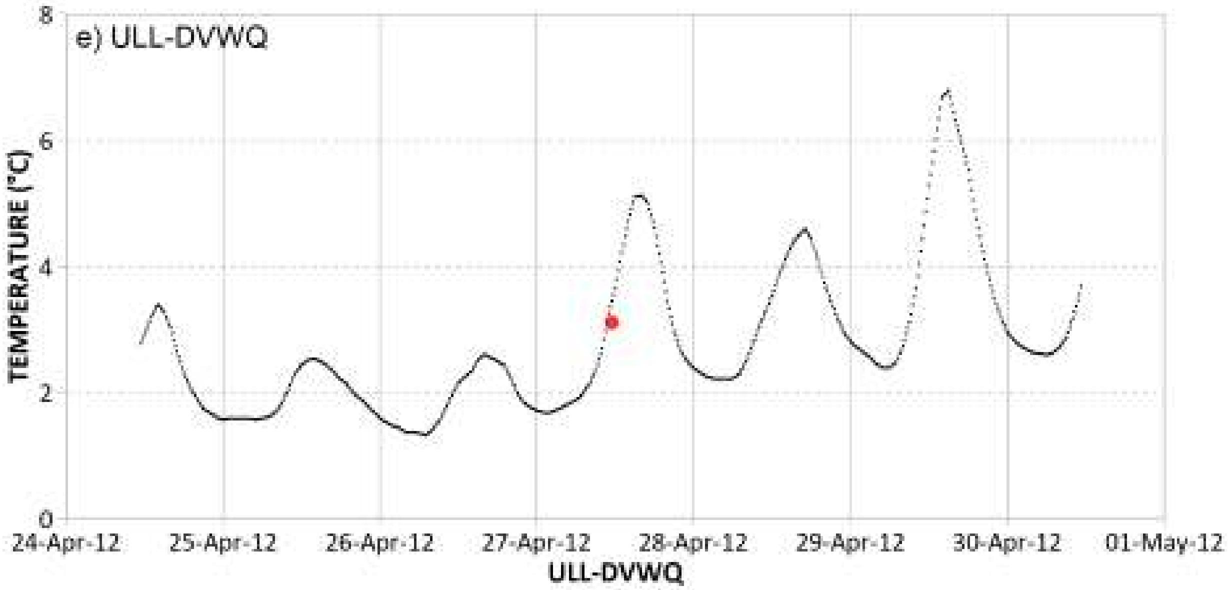


Figure 1. Continued.



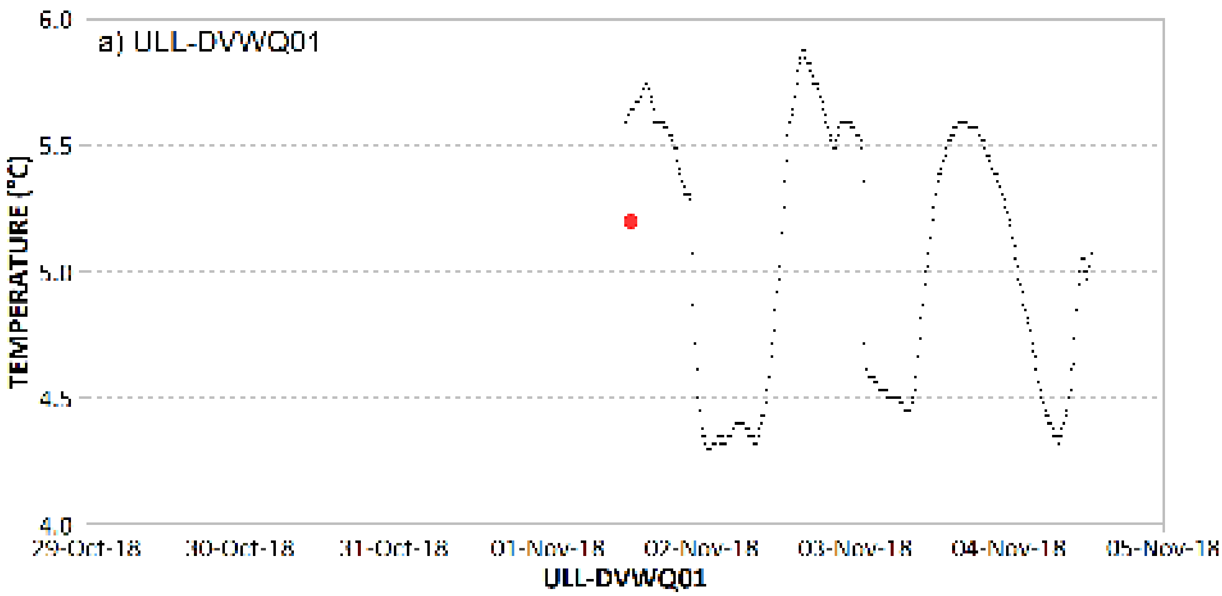
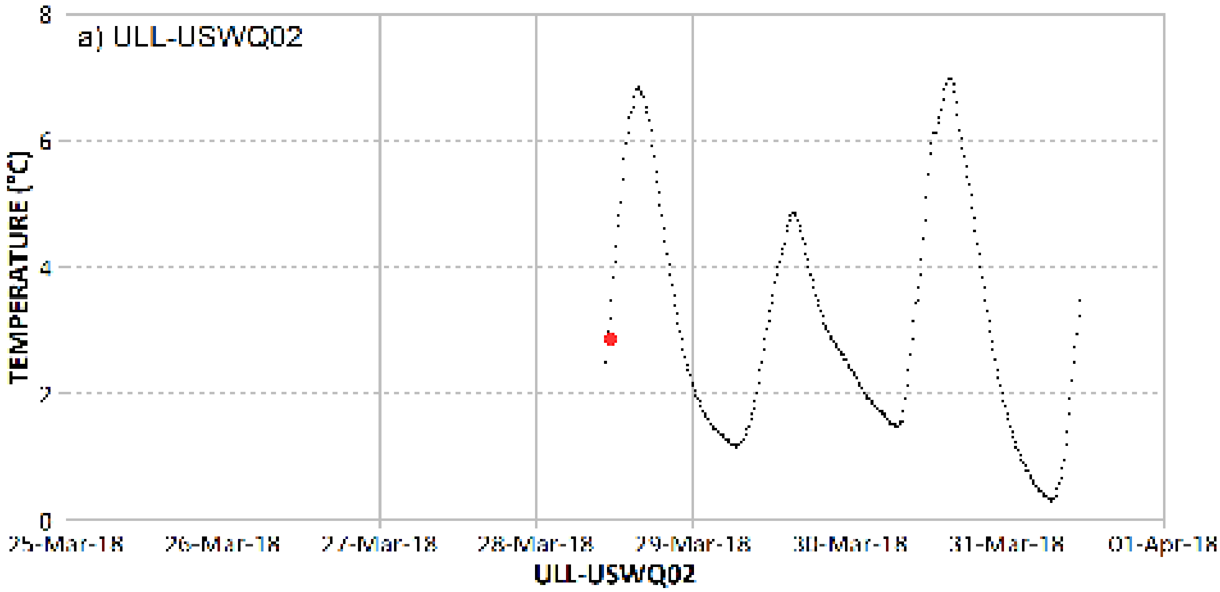


Figure 2. Spot temperature QA/QC plots for ULL-USWQ02 and ULL-USWQ03.



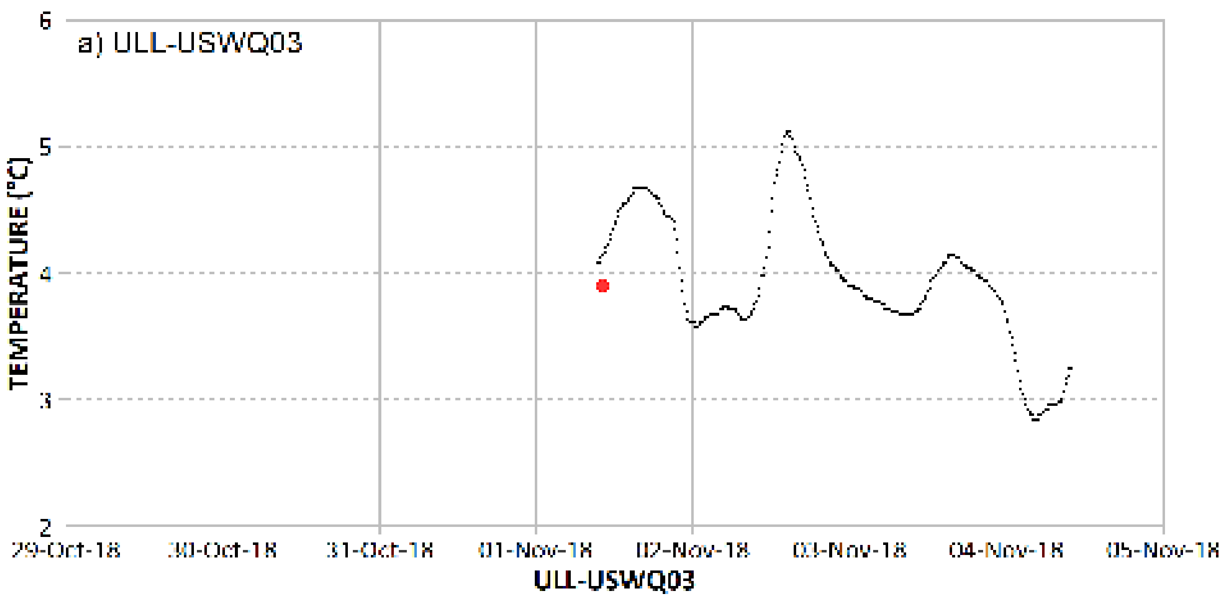
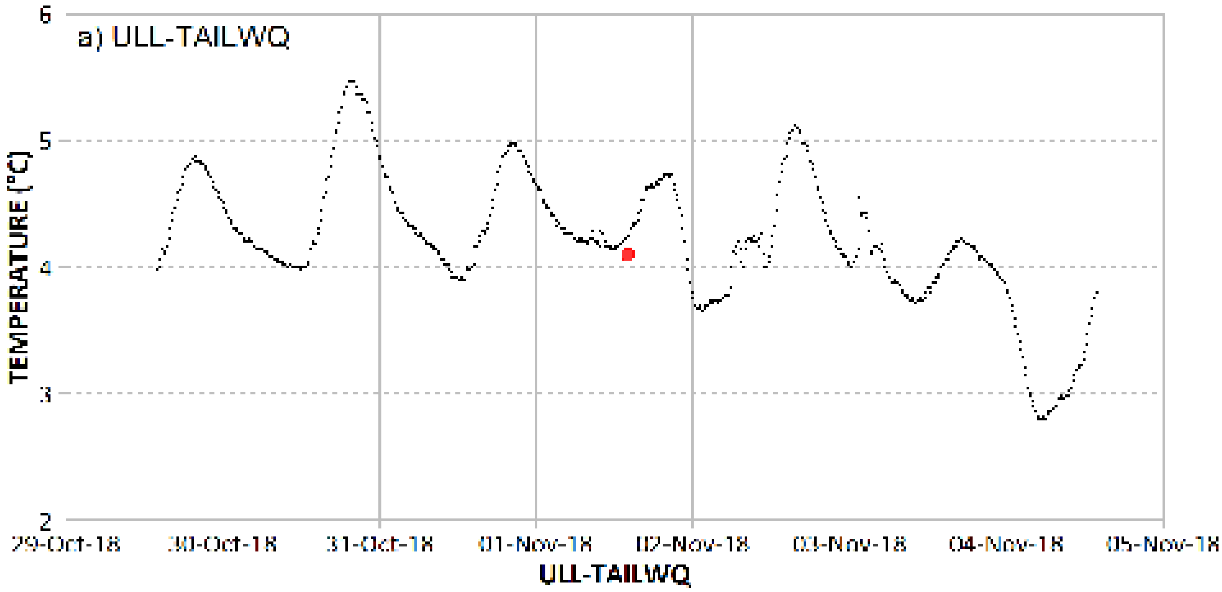


Figure 3. Spot temperature QA/QC plots for ULL-TAILWQ.



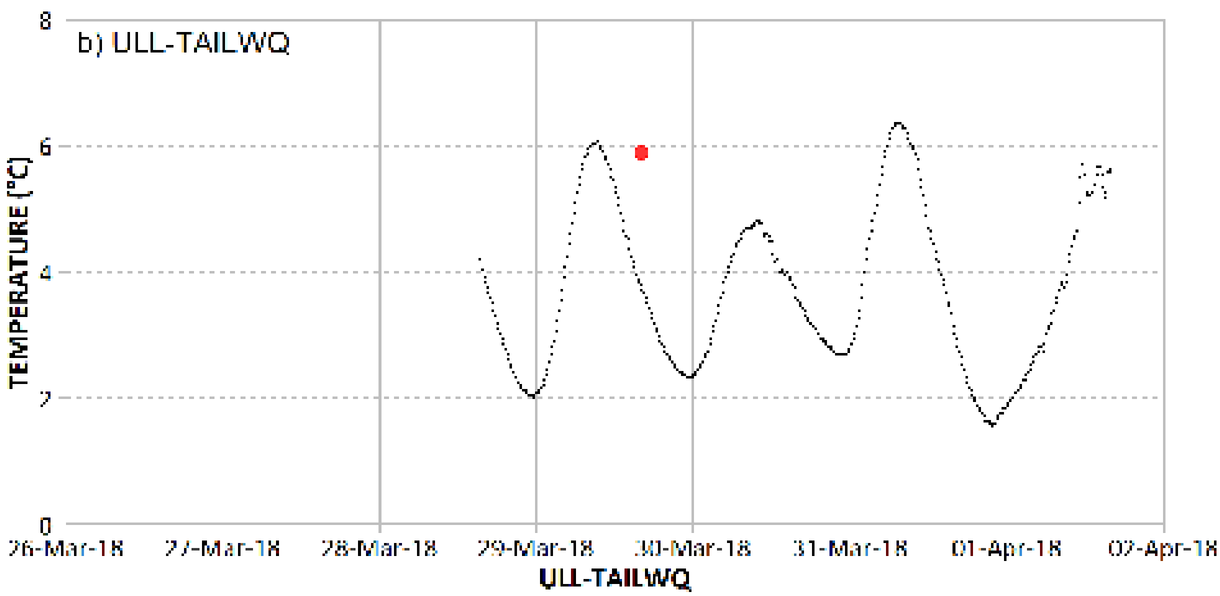
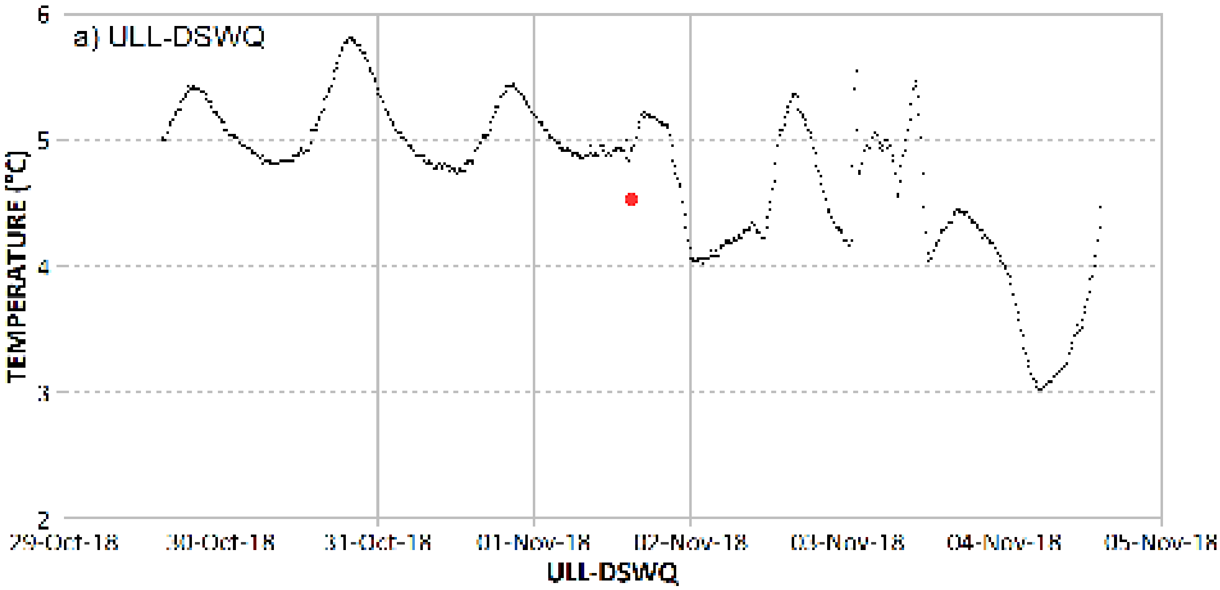
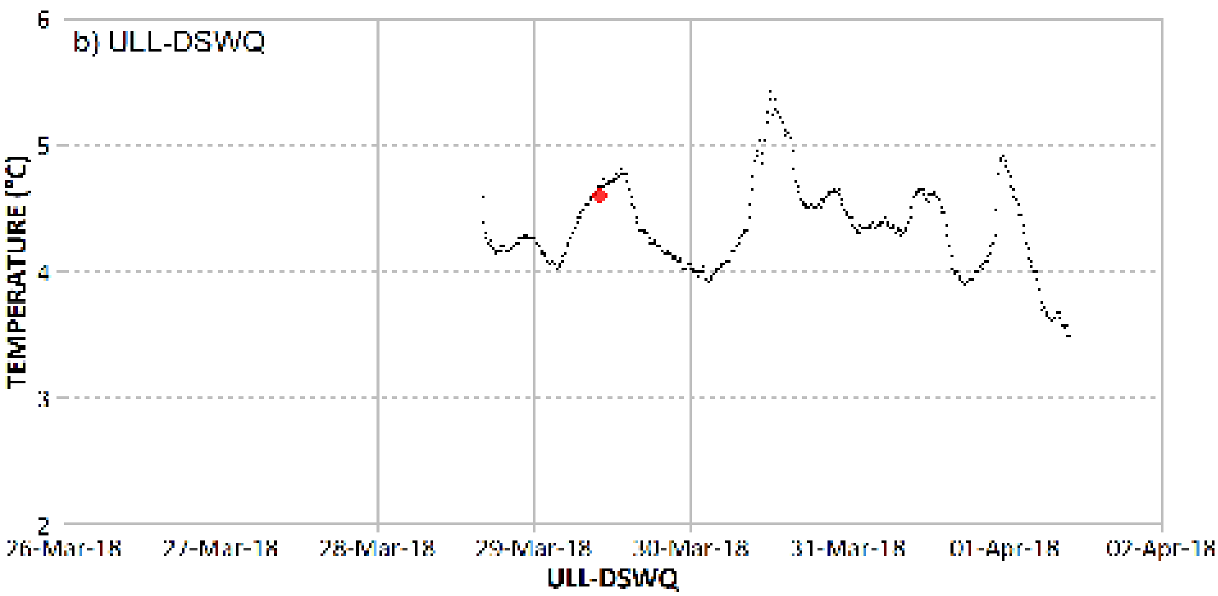
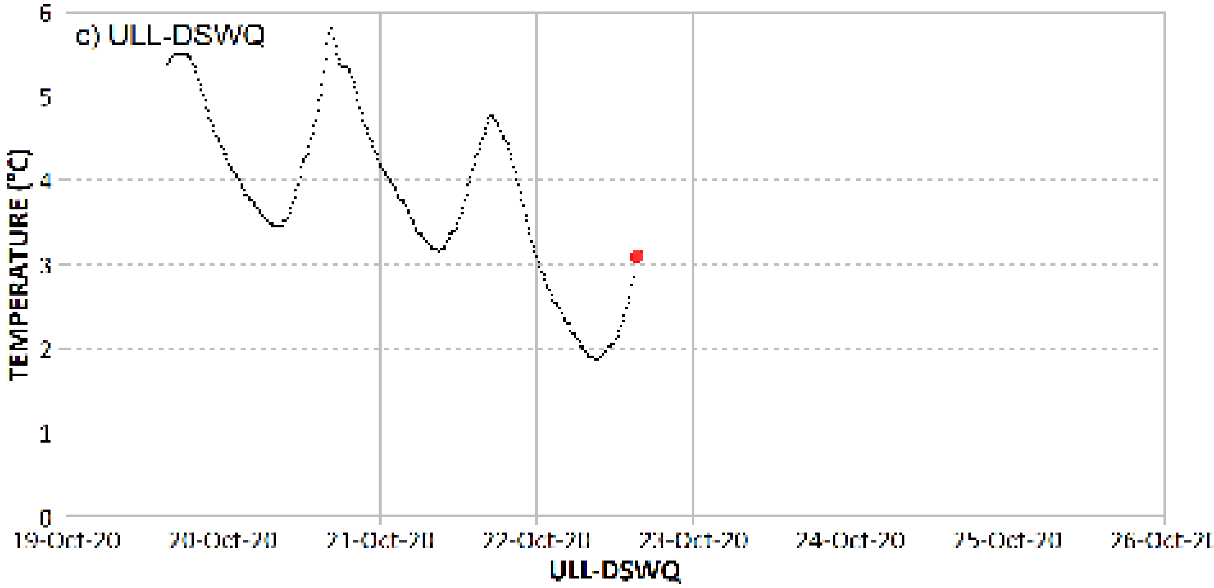


Figure 4. Spot temperature QA/QC plots for ULL-DSWQ.

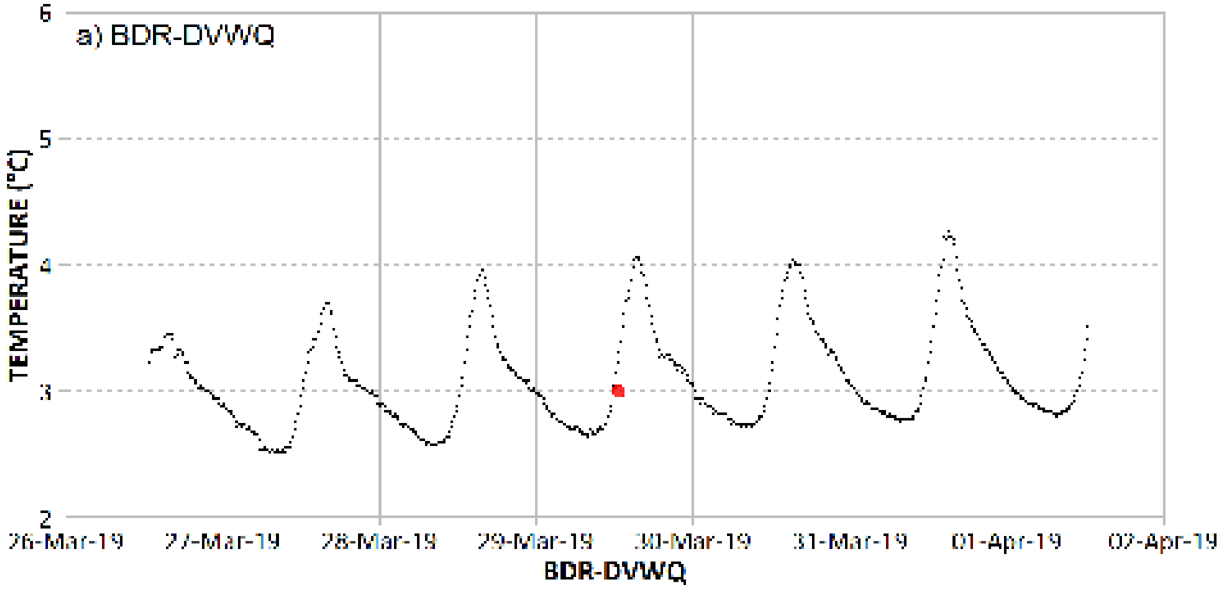





c) ULL-DSWQ
TEMPERATURE (°C)
0
1
2
3
4
5
6
19-Oct-20
20-Oct-20
21-Oct-20
22-Oct-20
23-Oct-20
24-Oct-20
25-Oct-20
26-Oct-20
ULL-DSWQ

1.2. Boulder Creek

Figure 5. Spot temperature QA/QC plots for BDR-DVWQ.



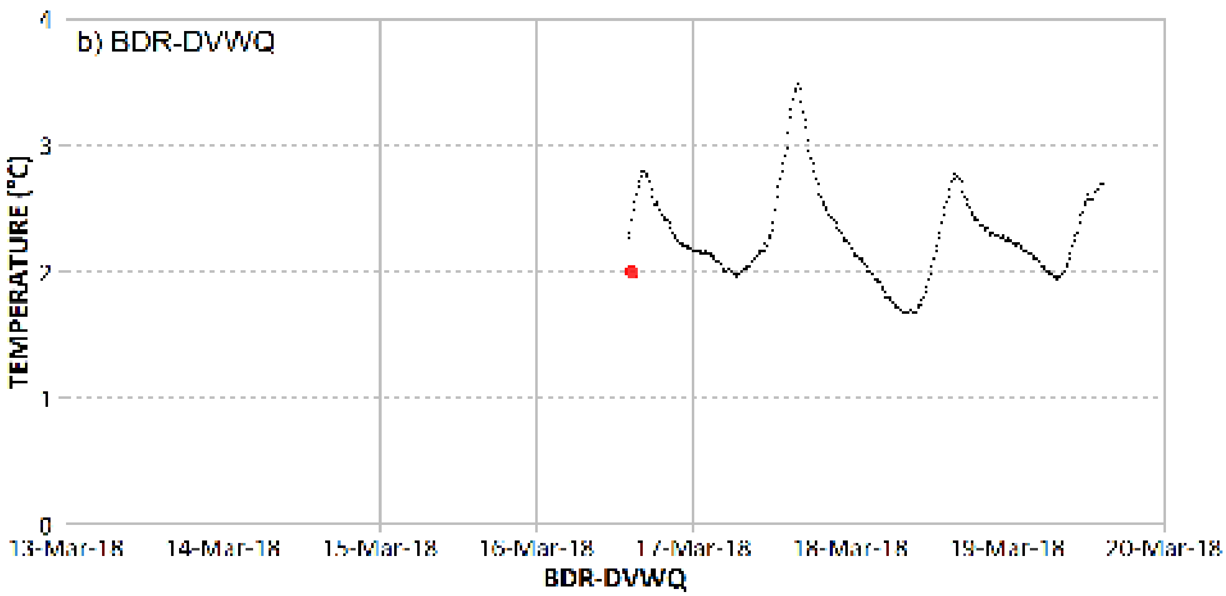
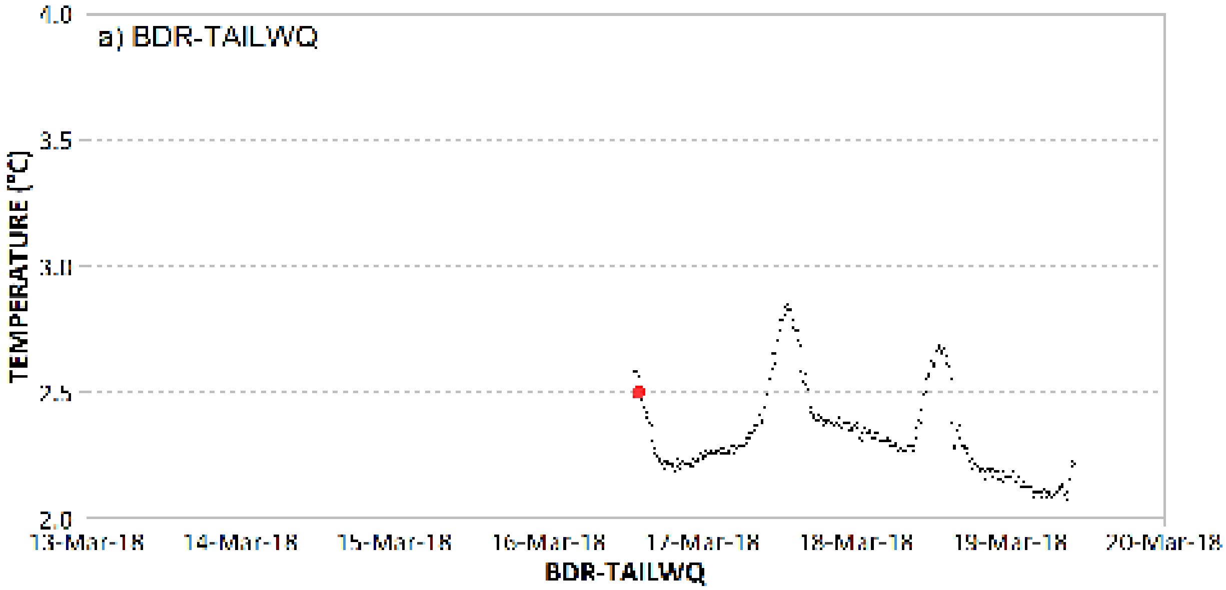


Figure 6. Spot temperature QA/QC plots for BDR-TAILWQ.



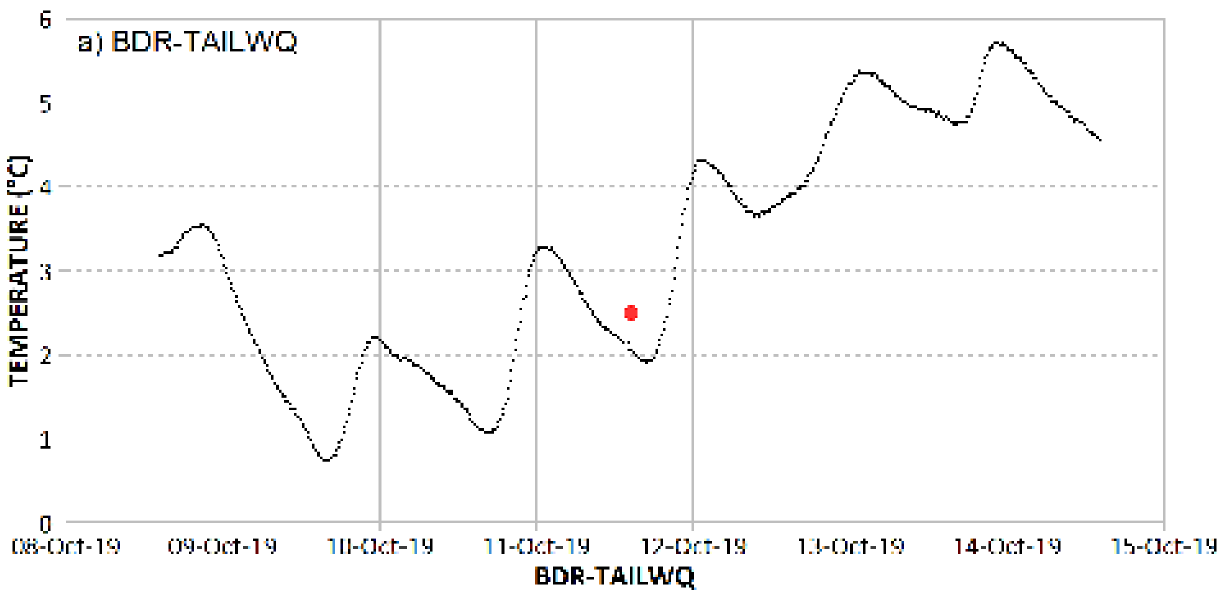
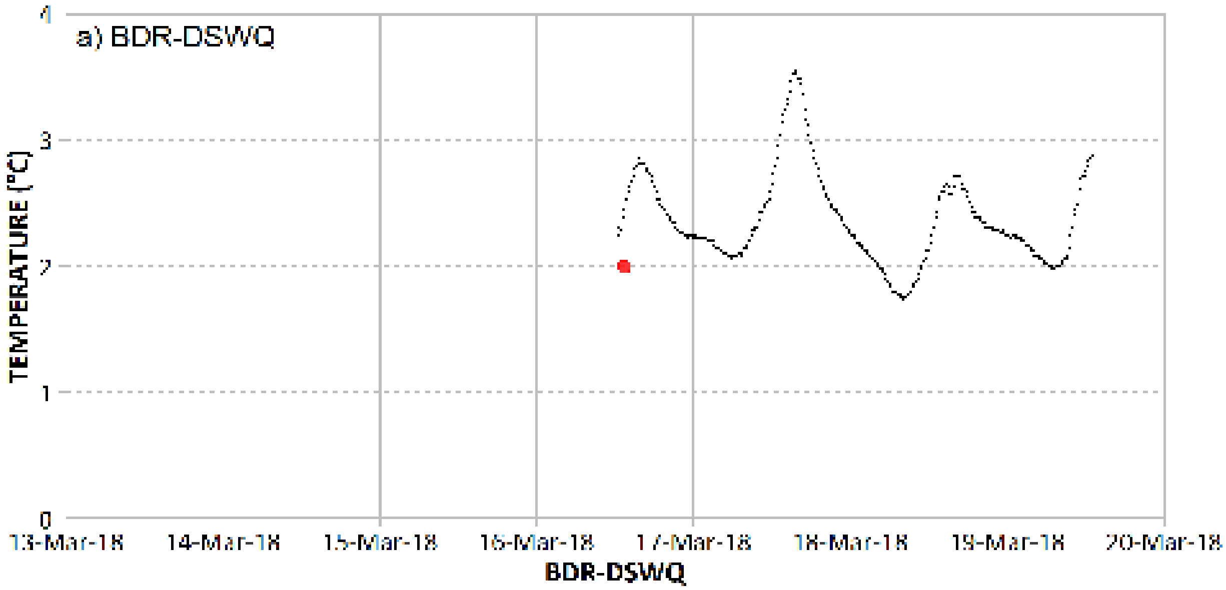


Figure 7. Spot temperature QA/QC plots for BDR-DSWQ.



Appendix I. Angling Site Representative Photographs, Site Conditions Summary, and Individual Fish Data

LIST OF FIGURES

LIST OF TABLES

Figure 1. Looking upstream at BDR-DVAG01 on September 15, 2020.

Figure 2. Looking downstream at BDR-DVAG04 on September 15, 2020.

Figure 3. Looking upstream at BDR-DVAG05 on September 15, 2020.

Figure 4. Looking downstream from river right at BDR-TRAG01 on September 15, 2020.

Figure 5. Looking downstream at BDR-DSAG01 on September 15, 2020.

Figure 6. Looking downstream at BDR-DSAG02 on October 1, 2020.

Figure 7. Looking upstream at BDR-DSAG06 on September 15, 2020.

Figure 8. Looking downstream at BDR-DSAG07 on September 15, 2020.

Figure 9. Looking upstream at ULL-DVAG15 on September 16, 2020.

Figure 10. Looking upstream at ULL-DVAG16 on September 16, 2020.

Figure 11. Looking from river right to river left at ULL-TRAG01 on September 16, 2020.

Figure 12. Looking upstream at ULL-DSAG08 on September 16, 2020.

Figure 13. Looking upstream from river left at ULL-DSAG09 on October 2, 2020.

Figure 14. Looking downstream at ULL-DSAG10 on September 16, 2020.

Figure 15. Looking downstream at NTH-DSAG01 on October 19, 2020.

Figure 16. Looking river right to river left at NTH-DSAG05 on October 19, 2020.

Figure 17. Looking downstream at NTH-DSAG06 on October 19, 2020.

Figure 18. Looking upstream at NTH-DVAG04 on October 19, 2020.

Figure 19. Looking upstream at NTH-DVAG05 on October 19, 2020.

Figure 20. Looking upstream at NTH-DVAG06 on October 19, 2020.

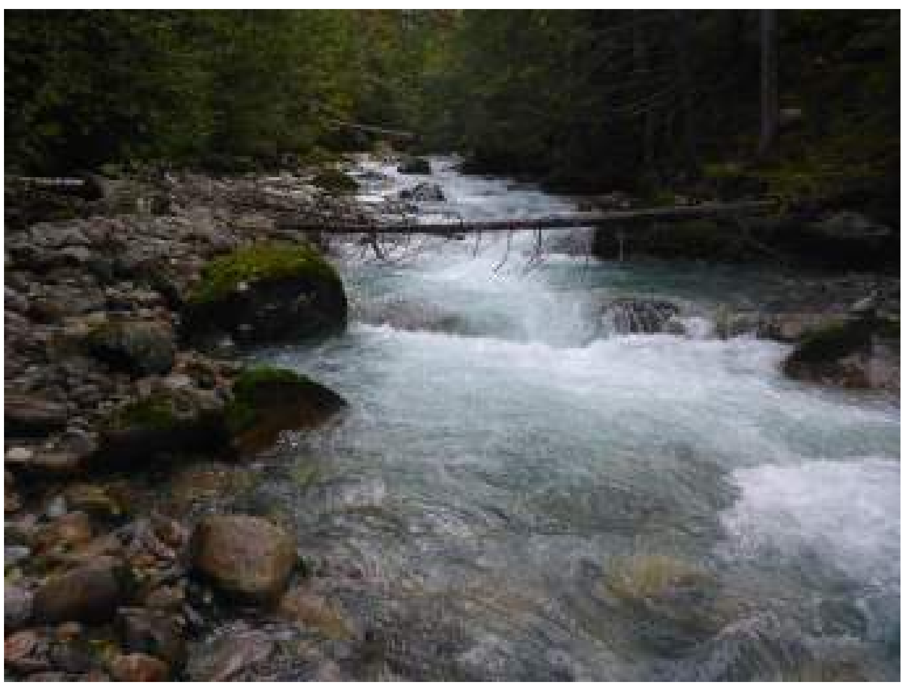


Table 1. Summary of angling sites in Boulder Creek in fall 2020.

Site	Habitat Type	Date	Water Temp. (°C)	Site Length (m)	Stream Wetted Width (m)	Average Angled Width (m)	Overall Site Area (m²)	Fished Area (m²)	Estimated Fishable Area (%)
BDR-DSAG01	Cascade	15-Sep	8.6	23.0	17.0	5.0	391	115	20
		1-Oct	8.4	29.0	14.0	6.0	406	348	40
		20-Oct	4.9	30.0	13.0	6.0	390	180	40
BDR-DSAG02	Cascade	15-Sep	8.6	28.0	18.0	4.0	504	112	20
		20-Oct	4.7	18.0	17.0	5.0	306	180	30
BDR-DSAG05	Cascade	1-Oct	8.6	18.0	17.0	4.0	306	144	30
BDR-DSAG06	Cascade	15-Sep	6.5	23.0	11.0	6.0	253	552	60
		1-Oct	7.9	28.0	12.0	5.0	336	140	40
		20-Oct	4.5	28.0	12.0	6.0	336	168	40
BDR-DSAG07	Riffle	15-Sep	9.4	68.0	27.0	3.0	1836	204	10
BDR-DVAG01	Cascade/Pool	15-Sep	9.4	30.0	7.0	5.0	210	150	70
		1-Oct	9.0	28.0	8.5	6.0	238	336	70
		20-Oct	5.6	30.0	8.0	6.0	240	180	70
BDR-DVAG03	Run	15-Sep	9.9	31.0	9.0	6.0	279	186	80
		1-Oct	9.3	45.0	7.0	5.0	315	225	50
		20-Oct	5.6	45.0	7.0	5.0	315	675	50
BDR-DVAG04	Cascade/Pool	15-Sep	9.4	32.0	10.0	8.0	320	256	70
		1-Oct	9.0	30.0	9.7	6.0	291	180	70
		20-Oct	5.6	30.0	9.5	6.0	285	360	70
BDR-DVAG05	Cascade	15-Sep	9.4	28.0	7.0	6.0	196	168	90
		1-Oct	8.8	35.0	8.4	4.0	294	420	60
		20-Oct	5.6	34.0	8.0	5.0	272	680	70
BDR-TRAG01	Run	15-Sep	6.5	40.0	9.0	6.0	360	240	80
		1-Oct	7.0	35.0	8.0	4.0	280	140	60
		20-Oct	4.3	35.0	8.0	6.0	280	1260	70

Table 2. Summary of angling sites in Lillooet River in fall 2020.

Site	Habitat Type	Date	Water Temp. (°C)	Site Length (m)	Stream Wetted Width (m)	Average Angled Width (m)	Overall Site Area (m²)	Fished Area (m²)	Estimated Fishable Area (%)
ULL-DSAG05	Run	16-Sep	5.9	16.0	33.0	4.0	528	64	15
ULL-DSAG08	Riffle/Pool	16-Sep	5.6	37.0	31.0	5.0	1147	185	25
		2-Oct	5.3	45.0	28.0	4.0	1260	180	15
		21-Oct	3.9	45.0	26.0	8.0	1170	360	30
ULL-DSAG09	Riffle/Pool	2-Oct	5.6	18.0	31.0	4.0	558	72	15
		21-Oct	3.4	18.0	28.0	5.0	504	90	20
ULL-DSAG10	Riffle/Pool	16-Sep	6.2	20.0	28.0	4.0	560	80	20
		2-Oct	5.6	24.0	28.0	3.0	672	72	10
		21-Oct	4.2	24.0	28.0	4.0	672	96	15
ULL-DVAG15	Cascade	16-Sep	8.7	39.0	20.0	4.0	780	156	20
		2-Oct	8.0	35.0	11.0	3.0	385	105	20
		21-Oct	4.6	35.0	10.0	4.0	350	140	50
ULL-DVAG16	Step/Pool	16-Sep	9.1	40.0	16.0	5.0	640	400	30
		2-Oct	6.0	31.0	13.7	3.0	424.7	279	20
		21-Oct	5.9	31.0	13.0	9.0	403	279	70
ULL-TRAG01	Step/Pool	16-Sep	6.3	16.0	40.0	3.0	640	48	10
		2-Oct	6.7	23.0	45.0	2.0	1035	46	10
		21-Oct	3.3	30.0	45.0	20.0	1350	600	50

Table 3. Summary of angling sites in North Creek in fall 2020.

Site [1]	Habitat Type	Date	Water Temp. (°C)	Site Length (m)	Stream Wetted Width (m)	Average Angled Width (m)	Overall Site Area (m²)	Fished Area (m²)	Estimated Fishable Area (%)
NTH-DSAG01	Riffle/Pool	17-Sep	11.2	12.0	10.0	2.0	120	24	20
		30-Sep	10.9	36.0	6.0	2.0	216	72	30
		19-Oct	7.0	36.0	7.0	2.5	252	90	30
NTH-DSAG05	Cascade/Pool	17-Sep	11.2	23.0	14.0	5.0	322	575	40
		30-Sep	10.7	14.0	10.0	5.0	140	70	50
		19-Oct	6.9	14.0	10.0	5.0	140	140	50
NTH-DSAG06	Run	17-Sep	10.7	22.0	8.0	4.0	176	176	50
		30-Sep	10.2	45.0	13.0	2.0	585	360	20
		19-Oct	6.5	45.0	13.0	4.0	585	180	30
NTH-DVAG04	Cascade/Pool	17-Sep	10.6	26.0	12.0	4.0	312	416	35
		30-Sep	9.9	28.5	12.0	3.5	342	399	30
		19-Oct	6.3	30.0	12.0	4.5	360	270	25
NTH-DVAG05	Cascade/Pool	17-Sep	9.5	29.0	12.0	3.0	348	174	30
		30-Sep	8.8	31.0	12.0	3.0	372	279	20
		19-Oct	5.9	31.0	12.0	3.0	372	93	20
NTH-DVAG06	Cascade/Pool	17-Sep	10.0	39.0	12.0	5.0	468	780	50
		30-Sep	8.8	39.0	11.0	4.0	429	780	30
		19-Oct	5.9	39.0	11.0	4.0	429	156	25

[1] Sites labels for North Creek are historic. No downstream or diversion exist.

Table 4. Summary of all fish captured during angling in Boulder Creek in 2020.

Reach	Date	Site	Species[1]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	Age Sample #	DNA Sample #	PIT Tag #
Diversion	15-Sep	BDR-DVAG01	NFC							
		BDR-DVAG04	NFC							
		BDR-DVAG05	BT	197	79	1.03330472	FR	5	5	Tag: 989001038120950
		BDR-DVAG03	BT	240	152	1.09953704	FR	6	6	Tag: 989001038120945
Tailrace	15-Sep	BDR-TRAG01	NFC							
Downstream	15-Sep	BDR-DSAG01	NFC							
		BDR-DSAG02	BT	189	74	1.09609023	FR	7	7	
		BDR-DSAG06	BT	275	223	1.07227648	FR	3	3	Tag: 989001038120951
			BT	198	80	1.03061015	FR	2	2	Tag: 989001038120921
			BT	252	183	1.14353502	FR	4	4	Tag: 989001038120955
			BT	240	101	0.73061343	FR	1	1	Tag: 989001038120940
		BDR-DSAG07	NFC							
Diversion	1-Oct	BDR-DVAG01	BT	473	1090	1.03001388			4	Tag: 989001038120884
			BT	172	60	1.17914146			5	Tag: 989001038120923
		BDR-DVAG04	NFC							
		BDR-DVAG05	BT	197	90	1.17718259			3	Tag: 989001038120898
			BT	324	323	0.94965857			2	Tag: 989001038120925
			BT	198	81	1.04349278				Tag: 989001038120950
		BDR-DVAG03	NFC							
Tailrace	1-Oct	BDR-TRAG01	BT	339	417	1.07037747			1	Tag: 989001038120902
Downstream	1-Oct	BDR-DSAG01	BT							
			BT							
		BDR-DSAG06	BT	182	60	0.99526123			6	Tag: 989001038120860
		BDR-DSAG05	BT	231	115	0.93295759			8	Tag: 989001038120943
			BT	167	40	0.85883667			7	Tag: 989001038120913

[1] BT = Bull Trout, CT = Cutthroat Trout, NFC = No fish caught.

Table 4. Continued.

Reach	Date	Site	Species[1]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	Age Sample #	DNA Sample #	PIT Tag #
Diversion	20-Oct	BDR-DVAG01	BT	219	93	0.8854226	FR	1	1	Tag: 9898001032067180
		BDR-DVAG04	BT	212	100	1.0495241	FR	2	2	Tag: 989001032067191
			BT	361	483	1.02665736	FR	1	1	Tag: 989001032067179
		BDR-DVAG05	BT	276	208	0.98931841			3	Tag: 989001032067194
			BT	271	208	1.04509426			1	Tag: 989001032067111
			BT	221	116	1.07468495	FR	2	2	Tag: 989001032067181
			BT	485	1220	1.0693863			4	Tag: 989001032067162
		BDR-DVAG03	BT	212	106	1.11249555				Tag: 989001006696326
			BT	206	95	1.08673072	FR	1	1	Tag: 989001032067187
			BT	275	120	0.57700977	FR	2	2	Tag: 989001032067178
Tailrace	20-Oct	BDR-TRAG01	BT	300	261	0.96666667	FR	1	1	Tag: 989001032067189
			BT	256	180	1.07288361				Tag: 989001031378634
			BT	192	76	1.07376664	FR	2	2	Tag: 989001032067193
			BT	211	106	1.12838811	FR	3	3	Tag: 989001032067161
			BT	209	95	1.04060222	FR	4	4	Tag: 989001032067206
			BT	379	459	0.843131	FR	5	5	Tag: 989001032067146
Downstream	20-Oct	BDR-DSAG01	BT	480	950	0.85901331			1	Tag: 989001032067170
		BDR-DSAG02	BT	410	669	0.97067657			2	Tag: 989001032067197
			BT	197	72	0.94174607	FR	1	1	Tag: 989001032067134
		BDR-DSAG06	BT	340	400	1.01770812				Tag: 989001006696285

[1] BT = Bull Trout, CT = Cutthroat Trout, NFC = No fish caught.

Table 5. Summary of all fish captured during angling in Lillooet River in 2020.

Reach	Date	Site	Species[1]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	Age Sample #	DNA Sample #	PIT Tag #
Diversion	16-Sep	ULL-DVAG15	BT	190	68	0.99139816	FR	1	1	Tag: 989001038120930
		ULL-DVAG16	BT	180	59	1.01165981	FR	3	3	Tag: 989001038120954
			BT	266	181	0.96168682	FR	2	2	Tag: 989001038120933
Tailrace	16-Sep	ULL-TRAG01	NFC							
Downstream	16-Sep	ULL-DSAG08	NFC							
		ULL-DSAG10	NFC							
		ULL-DSAG05	NFC							
Diversion	2-Oct	ULL-DVAG15	NFC							
		ULL-DVAG16	BT	407	700	1.03828077			1	Tag: 989001038120869
			BT	178	70	1.24118933			3	Tag: 989001038120948
			CT	251	120	0.75885724	SC	1	2	Tag: 989001038120875
Tailrace	2-Oct	ULL-TRAG01	BT	283	210	0.92653107				Tag: 989001031378546
Downstream	2-Oct	ULL-DSAG08	NFC							
		ULL-DSAG09	NFC							
		ULL-DSAG10	NFC							
Diversion	21-Oct	ULL-DVAG15	NFC							
		ULL-DVAG16	NFC							
Tailrace	21-Oct	ULL-TRAG01	NFC							
Downstream	21-Oct	ULL-DSAG08	NFC							
		ULL-DSAG09	CT	116	98	6.2784452	SC	1	1	Tag: 989001032067200
		ULL-DSAG10	NFC							

[1] BT = Bull Trout, CT = Cutthroat Trout, NFC = No fish caught.

Table 6. Summary of all fish captured during angling in North Creek in 2020.

Date	Site[1]	Species[2]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	Age Sample #	DNA Sample #	PIT Tag #
17-Sep	NTH-DVAG06	BT	375	528	1.00124444			5	Tag: 989001038120894
		BT	455	981	1.04144135			3	Tag: 989001038120934
		BT	185	69	1.08976763	FR	4	4	Tag: 989001038120893
		BT	281	233	1.05011524	FR	6	6	Tag: 989001038120914
	NTH-DVAG05	BT	340	353	0.89812742	FR	2	2	Tag: 989001038120935
		BT	488	1250	1.07559939			1	Tag: 989001038120899
	NTH-DVAG04	BT	168	47	0.9912199	FR	9	9	Tag: 989001038120858
		BT	405	685	1.03115868			7	Tag: 989001038120900
		BT	241	137	0.97874474	FR	8	8	Tag: 989001038120878
		BT	177	57	1.02790992	FR	10	10	Tag: 989001038120909
17-Sep	NTH-DSAG06	BT	382					11	Tag: 989001038120905
		BT	424					12	Tag: 989001038120917
	NTH-DSAG05	BT	575	2004	1.05413002			13	Tag: 989001038120904
		BT	252			FR	14	14	Tag: 989001038120949
		BT	245						
		BT	248			FR	15	15	Tag: 989001038120890
		BT	162			FR	16	16	Tag: 989001038120936
17-Sep	NTH-DSAG01	BT	342	460	1.14995147			17	Tag: 989001038120885
30-Sep	NTH-DVAG06	BT	402	620	0.95436286			4	Tag: 989001038120922
		BT	390	543	0.91538967			5	Tag: 989001038120912
		BT	386	586	1.01890971			6	Tag: 989001038120911
		BT	334	313	0.84004961				Tag: 989001038120935
		BT	316	322	1.0204568			7	Tag: 989001038120876

[1] Sites labels are historic. No downstream or diversion exist for North Creek

[2] BT = Bull Trout, CT = Cutthroat Trout, NFC = No fish caught.

Table 6. Continued.

Date	Site[1]	Species[2]	Measured Length (mm)	Weight (g)	Condition Factor (K)	Age Structure	Age Sample #	DNA Sample #	PIT Tag #
30-Sep	NTH-DVAG05	BT	425	706	0.91968248			3	Tag: 989001038120957
		BT	272	199	0.98888631			1	Tag: 989001038120864
		BT	262	190	1.0564519			2	Tag: 989001038120886
30-Sep	NTH-DVAG04	BT	374	450	0.86019657			8	Tag: 989001038920867
		BT	370	550	1.0858192			9	Tag: 989001038120910
		BT	415	740	1.03535058				Tag: 989001038120917
		BT	341	370	0.93312234			10	Tag: 989001038120889
30-Sep	NTH-DSAG06	BT	259	160	0.92091742			11	Tag: 989001038120953
		BT	413	730	1.03626947			12	Tag: 989001038120901
		BT	176	50	0.91713233			13	Tag: 989001038120946
		BT	196	80	1.06248247			14	Tag: 989001038120861
30-Sep	NTH-DSAG05	BT	425	780	1.01607979			15	Tag: 989001038120887
30-Sep	NTH-DSAG01	BT	304	260	0.92544923			16	Tag: 989001038120932
19-Oct	NTH-DVAG06	BT	289	222	0.91972808			1	Tag: 989001032067188
19-Oct	NTH-DVAG05	NFC							
19-Oct	NTH-DVAG04	BT	375	535	1.01451852				Tag: 989001038120905
		BT	181	65	1.09616929			1	Tag: 989001032067172
19-Oct	NTH-DSAG06	BT	184	64	1.02736911			1	Tag: 989001032067190
19-Oct	NTH-DSAG05	BT	410	672	0.97502938			1	Tag: 989001032067185
		BT	251	155	0.9801906				Tag: 989001038120949
19-Oct	NTH-DSAG01	BT	291	273	1.10785693			1	Tag: 989001032067198

[1] Sites labels are historic. No downstream or diversion exist for North Creek

[2] BT = Bull Trout, CT = Cutthroat Trout, NFC = No fish caught.

Appendix J. Incidental Wildlife Observations

LIST OF TABLES

Table 1. Incidental wildlife sightings: Mammals.

Species		Date	Time	UTM Coordinates (10U)		Location	Sighting or Sign	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing							
American Black Bear	*Ursus americanus*	21-May-2020	12:00:00	471263	5609386	BDR Powerhouse	Sighting		1	TF	U	Adult
		30-May-2020	08:00:00	466403	5614657	46.5km ULL FSR	Sighting	Mother bear with 3 cubs acted defensively	1	TF	F	Adult
		30-May-2020	8:00:00	466403	5614657	46.5km ULL FSR	Sighting	3 cubs with mother	3	TF	U	Cub (Unknown)
		1-Jun-2020	07:55:00	498141	5596079	6km ULL FSR	Sighting	UTM coordinates estimated	1	FD	U	Cub (COY)
		1-Jun-2020	08:00:00	491385	5598591	14km ULL FSR	Sighting	UTM coordinates estimated	1	FD	U	Unknown
		1-Jun-2020	08:15:00	474835	5605541	33km ULL FSR	Sighting	UTM coordinates estimated	1	TF	U	Unknown
		28-Jun-2020	20:00:00	471163	5609510	BDR Camp	Sighting	Adult with cub; UTM coordinates estimated	1	FD	U	Adult
		28-Jun-2020	20:00:00	471163	5609510	BDR Camp	Sighting	UTM coordinates estimated	1	FD	U	Cub(Unknown)
		14-Aug-2020	17:00:00	470236	5609992	40km ULL FSR	Sighting	Adult with cubs; UTM coordinates estimated	1	TF	F	Adult
		14-Aug-2020	17:00:00	470236	5609992	40km ULL FSR	Sighting	UTM coordinates estimated	2	TF	U	Cub(Unknown)
		15-Aug-2020	07:00:00	471373	5608438	38km ULL FSR	Sighting		1	TF	M	Adult
Bobcat	*Lynx rufus*	20-Nov-2020		501216	5595120	2.5km ULL FSR	Sighting	UTM coordinates estimated	2	LI	U	Adult
Elk	*Cervus canadensis*	27-Sep-2020		471122	5608825	38.5km ULL FSR	Sighting	UTM coordinates estimated	1	TF	M	Adult
Grizzly Bear	*Ursus arctos*	13-Jul-2020	08:00:00	471373	5608446	38km ULL FSR	Sighting	UTM coordinates estimated	1	TF	U	Unknown
		23-Jul-2020	07:00:00	471122	5608825	38.5km ULL FSR	Sighting	UTM coordinates estimated	1	TF	U	Unknown
		24-Jul-2020	07:01:00	471131	5609318	BDR Powerhouse driveway	Sighting	UTM coordinates estimated	1	TF	U	Adult
		9-Nov-2020	07:15:00	477097	5603827	30km ULL FSR	Sighting	UTM coordinates estimated	1	TF	U	Unknown

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 1. Continued.

Species		Date	Time	UTM Coordinates (10U)		Location	Sighting or Sign	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing							
Hoary Marmot	*Marmota caligata*	17-Jun-2020	11:00:00	472751	5611010	BDR intake access road	Sighting	between BDR-CAM04 and CAM08 on spur road. size, shape and markings consistent with species. ran away when we arrived	1	FL	U	Unknown
Mammal		18-Jun-2020	13:30:00	469096	5609722	ULL Diversion at 40.5 km FSR; upslope on RR bank	Sighting	large mammal. appeared to be very large bear possibly foraging/feeding on spring snow beneath waterfall. too distant to be certain of species	1	LI	U	Unknown
Moose	*Alces americanus*	4-Jan-2020	12:00:00	470957	5609342	39km ULL FSR	Sighting	Walking down the road.	1	TF	M	Adult
		5-Feb-2020	10:00:00	488809	5599847	17km ULL FSR	Sighting	UTM coordinates estimated	3	FL	U	Adult
		19-Jul-2020	22:00:00	491385	5598591	14km ULL FSR	Sighting	Cow and calf; UTM coordinates estimated	1	TF	F	Adult
		19-Jul-2020	22:00:00	491385	5598591	14km ULL FSR	Sighting	Cow and calf; UTM coordinates estimated	1	TF	U	Calf
		9-Nov-2020	07:00:00	494769	5598159	10.5km ULL FSR	Sighting	UTM coordinates estimated	1	FL	M	Adult
			07:03:00	493296	5598106	12km ULL FSR	Sighting	UTM coordinates estimated	1	FL	F	Adult
		18-Dec-2020	13:00:00	478815	5603160	28km ULL FSR	Sighting	Feeding along road; UTM coordinates estimated	2	FD	M	Unknown
Mountain Goat	*Oreamnos americanus*	29-Oct-2020	16:00:00	499981	5595770	4km ULL FSR	Sighting	UTM coordinates estimated	1	LI	U	Unknown

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 2. Incidental wildlife sightings: Avian.

Species		Date	Time	UTM Coordinates (10U)		Location	Sighting or Sign	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing							
Bald Eagle	*Haliaeetus leucocephalus*	28-Jun-2020	06:30:00	471263	5609386	BDR Powerhouse	Sighting	UTM coordinates estimated	1	TF	U	Unknown
Barrow's Goldeneye	*Bucephala islandica*	20-Apr-2020	07:00:00	466103	5614089	ULL headpond	Sighting		1	LI	U	Unknown
		6-May-2020	10:48:00	466104	5614060	ULL Intake	Sighting		5	FD	F	Adult
		6-May-2020	10:48:00	466104	5614060	ULL Intake	Sighting		4	FD	M	Adult
Duck	*unidentified species*	20-Apr-2020	07:00:00	466103	5614089	ULL headpond			4	LI	U	Adult
Owl	*unidentified species*	25-May-2020	08:00:00	488467	5600028	17.5km ULL FSR	Sighting	UTM coordinates estimated	1	LI	U	Unknown

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 3. Truckwash Creek Wildlife Camera Observations: Mammal.

Species		Date	Time	UTM Coordinates (10U)		Location	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing						
American Black Bear	*Ursus americanus*	6-Jul-2019	19:12:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		21-Jul-2019	15:55:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		30-Jul-2019	09:06:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		4-Aug-2019	05:35:00	467982	5612841	ULL-CAM15		1	TF	U	Cub
		6-Aug-2019	07:33:00	467982	5612841	ULL-CAM15		1	TF	F	Adult
		6-Aug-2019	07:41:00	467982	5612841	ULL-CAM15		1	TF	U	Cub
		13-Aug-2019	19:57:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		16-Aug-2019	14:56:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		29-Aug-2019	18:05:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		12-Sep-2019	07:21:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		23-May-2020	15:40:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		25-Jun-2020	14:17:00	467982	5612841	ULL-CAM15	heading upslope	1	TF	U	Adult
		28-Jun-2020	07:22:00	467982	5612841	ULL-CAM15	heading up trail	1	TF	U	Adult
		6-Jul-2020	18:36:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		8-Jul-2020	15:13:00	467946	5613055	ULL-CAM02		1	FD	F	Adult
		8-Jul-2020	15:13:00	467946	5613055	ULL-CAM02		2	FD	U	Cub
		11-Jul-2020	06:52:00	467982	5612841	ULL-CAM15	heading up trail with cub, possibly same mother observed on CAM02 July 8, 2020 (similar colourations).				
		11-Jul-2020	6:52:00	467982	5612841	ULL-CAM15		1	TF	U	Cub
		17-Jul-2020	10:30:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		19-Jul-2020	10:54:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		24-Jul-2020	08:00:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		28-Jul-2020	07:41:00	467982	5612841	ULL-CAM15	looks like same mom and cub observed earlier	1	TF	F	Adult

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 3. Continued.

Species		Date	Time	UTM Coordinates (10U)		Location	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing						
American Black Bear	*Ursus americanus*	28-Jul-2020	07:42:00	467982	5612841	ULL-CAM15		1	TF	U	Cub
		30-Jul-2020	09:13:00	467982	5612841	ULL-CAM15	heading up trail	1	TF	U	Cub
		31-Jul-2020	20:01:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		6-Aug-2020	19:33:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		9-Aug-2020	09:20:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		11-Aug-2020	10:41:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		31-Aug-2020	05:01:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		3-Sep-2020	08:14:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		11-Sep-2020	10:28:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		28-Sep-2020	16:36:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
American Marten	*Martes americana*	27-Sep-2020	05:00:00	467982	5612841	ULL-CAM15		1	TF	U	U
Bobcat	*Lynx rufus*	25-Nov-2019	10:03:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
Cougar	*Puma concolor*	19-Sep-2019	05:49:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		22-Sep-2019	15:42:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		27-Sep-2019	05:46:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		1-Nov-2019	06:26:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		1-Nov-2019	16:13:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		26-Jun-2020	22:36:00	467982	5612841	ULL-CAM15	moved downslope, then back up trail	1	TF	U	Adult
Fisher	*Pekania pennanti*	11-Apr-2020	16:46:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
Mountain Goat	*Oreamnos americanus*	21-Apr-2020	16:52:00	467982	5612841	ULL-CAM15	with kid	1	TF	F	Adult
		21-Apr-2020	16:52:00	467982	5612841	ULL-CAM15		1	TF	U	Kid
		21-Apr-2020	16:53:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		23-Apr-2020	13:28:00	467946	5613055	ULL-CAM02	heading upslope	1	TF	F	Adult
		23-Apr-2020	13:28:00	467946	5613055	ULL-CAM02		1	TF	U	Kid
		3-May-2020	04:14:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		4-May-2020	13:00:00	467946	5613055	ULL-CAM02	travelling downslope	1	TF	U	Adult
		5-May-2020	13:49:00	467946	5613055	ULL-CAM02	travelling upslope	2	TF	U	Adult
		5-May-2020	16:28:00	467946	5613055	ULL-CAM02	hiding behind the bushes	2	TF	U	Adult

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 3. Continued.

Species		Date	Time	UTM Coordinates (10U)		Location	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing						
Mule Deer	*Odocoileus hemionus*	26-Jun-2019	06:06:00	467982	5612841	ULL-CAM15		1	TF		
		28-Jun-2019	08:49:00	467982	5612841	ULL-CAM15		1	TF		
		1-Jul-2019	19:37:00	467982	5612841	ULL-CAM15		1	TF		
		3-Jul-2019	05:16:00	467982	5612841	ULL-CAM15		1	TF		
		14-Jul-2019	10:15:00	467982	5612841	ULL-CAM15		1	TF		
		15-Jul-2019	01:19:00	467982	5612841	ULL-CAM15		1	TF		
		18-Jul-2019	01:15:00	467982	5612841	ULL-CAM15		3	TF		
		19-Jul-2019	13:56:00	467982	5612841	ULL-CAM15		1	TF		
		20-Jul-2019	11:51:00	467982	5612841	ULL-CAM15		1	TF		
		21-Jul-2019	22:45:00	467982	5612841	ULL-CAM15		1	TF		
		22-Jul-2019	00:12:01	467982	5612841	ULL-CAM15		2	TF		
		23-Jul-2019	04:45:00	467982	5612841	ULL-CAM15		2	TF		
		27-Jul-2019	05:43:00	467982	5612841	ULL-CAM15		1	TF		
		28-Jul-2019	05:50:00	467982	5612841	ULL-CAM15		3	TF		
		29-Jul-2019	23:00:00	467982	5612841	ULL-CAM15		1	TF		
		30-Jul-2019	00:19:00	467982	5612841	ULL-CAM15		1	TF		
		30-Jul-2019	13:22:00	467982	5612841	ULL-CAM15		1	TF		
		4-Aug-2019	21:43:00	467982	5612841	ULL-CAM15		2	TF		
		6-Aug-2019	02:39:00	467982	5612841	ULL-CAM15		2	TF		
		16-Aug-2019	21:51:00	467982	5612841	ULL-CAM15		3	TF		
		26-Aug-2019	22:51:00	467982	5612841	ULL-CAM15		1	TF		
		30-Aug-2019	21:54:00	467982	5612841	ULL-CAM15		1	TF		
		5-Sep-2019	02:45:00	467982	5612841	ULL-CAM15		1	TF		
		12-Sep-2019	02:47:00	467982	5612841	ULL-CAM15		1	TF		
		17-Sep-2019	10:41:00	467982	5612841	ULL-CAM15		2	TF		
		1-Oct-2019	21:52:00	467982	5612841	ULL-CAM15		1	TF		

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 3. Continued.

Species		Date	Time	UTM Coordinates (10U)		Location	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing						
Mule Deer	*Odocoileus hemionus*	28-Apr-2020	19:21:00	467982	5612841	ULL-CAM15		1	TF		
		1-May-2020	20:08:00	467982	5612841	ULL-CAM15		1	TF		
		2-May-2020	02:24:00	467982	5612841	ULL-CAM15		1	TF		
		4-May-2020	07:16:00	467982	5612841	ULL-CAM15		4	TF		
		5-May-2020	01:10:00	467982	5612841	ULL-CAM15		9	TF		
		6-May-2020	21:31:00	467982	5612841	ULL-CAM15		2	TF		
		7-May-2020	21:37:00	467982	5612841	ULL-CAM15		4	TF		
		8-May-2020	08:22:00	467982	5612841	ULL-CAM15		5	TF		
		9-May-2020	07:04:00	467982	5612841	ULL-CAM15		10	TF		
		10-May-2020	05:03:00	467982	5612841	ULL-CAM15		10	TF		
		11-May-2020	03:00:00	467982	5612841	ULL-CAM15		5	TF		
		12-May-2020	04:26:00	467982	5612841	ULL-CAM15		26	TF		
		13-May-2020	05:15:00	467982	5612841	ULL-CAM15		1	TF		
		14-May-2020	01:03:00	467982	5612841	ULL-CAM15		18	TF		
		15-May-2020	01:04:00	467982	5612841	ULL-CAM15		12	TF		
		16-May-2020	03:15:00	467982	5612841	ULL-CAM15		18	TF		
		17-May-2020	06:57:00	467982	5612841	ULL-CAM15		1	TF		
		18-May-2020	07:10:00	467982	5612841	ULL-CAM15		9	TF		
		19-May-2020	01:41:00	467982	5612841	ULL-CAM15		1	TF		
		20-May-2020	05:29:00	467982	5612841	ULL-CAM15		5	TF		
		21-May-2020	17:44:00	467982	5612841	ULL-CAM15		1	TF		
		22-May-2020	04:27:00	467982	5612841	ULL-CAM15		11	TF		
		23-May-2020	19:08:00	467982	5612841	ULL-CAM15		1	TF		
		24-May-2020	01:09:00	467982	5612841	ULL-CAM15		6	TF		
		26-May-2020	00:14:00	467982	5612841	ULL-CAM15		4	TF		
		27-May-2020	03:37:00	467982	5612841	ULL-CAM15		3	TF		

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 3. Continued.

Species		Date	Time	UTM Coordinates (10U)		Location	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing						
Mule Deer	*Odocoileus hemionus*	28-May-2020	04:13:00	467982	5612841	ULL-CAM15		7	TF		
		29-May-2020	05:46:00	467982	5612841	ULL-CAM15		4	TF		
		30-May-2020	03:28:00	467982	5612841	ULL-CAM15		7	TF		
		1-Jun-2020	08:24:00	467982	5612841	ULL-CAM15		5	TF		
		2-Jun-2020	02:05:00	467982	5612841	ULL-CAM15		1	TF		
		4-Jun-2020	05:49:00	467982	5612841	ULL-CAM15		3	TF		
		5-Jun-2020	03:02:00	467982	5612841	ULL-CAM15		1	TF		
		6-Jun-2020	07:38:00	467982	5612841	ULL-CAM15		1	TF		
		7-Jun-2020	03:17:00	467982	5612841	ULL-CAM15		2	TF		
		9-Jun-2020		467982	5612841	ULL-CAM15		3	TF		
		11-Jun-2020	04:43:00	467982	5612841	ULL-CAM15		1	TF		
		13-Jun-2020	11:05:00	467982	5612841	ULL-CAM15		2	TF		
		15-Jun-2020		467982	5612841	ULL-CAM15		3	TF		
		16-Jun-2020	03:55:00	467982	5612841	ULL-CAM15		1	TF		
		17-Jun-2020	18:22:00	467982	5612841	ULL-CAM15		1	TF	M	Adult
		18-Jun-2020	02:54:00	467982	5612841	ULL-CAM15		1	TF		
		19-Jun-2020	08:33:00	467982	5612841	ULL-CAM15		1	TF		
		20-Jun-2020	04:42:00	467982	5612841	ULL-CAM15		1	TF		
		21-Jun-2020	22:22:00	467982	5612841	ULL-CAM15		1	TF		
		24-Jun-2020	05:27:00	467982	5612841	ULL-CAM15		1	TF		
		25-Jun-2020	10:32:00	467982	5612841	ULL-CAM15		2	TF		
		26-Jun-2020	09:38:00	467982	5612841	ULL-CAM15		1	TF		
		30-Jun-2020	08:38:00	467982	5612841	ULL-CAM15		1	TF		
		3-Jul-2020	02:47:00	467982	5612841	ULL-CAM15		1	TF		
		4-Jul-2020	06:06:00	467982	5612841	ULL-CAM15		3	TF		
		5-Jul-2020	00:24:00	467982	5612841	ULL-CAM15		1	TF		
		6-Jul-2020	09:58:00	467982	5612841	ULL-CAM15		1	TF		
		8-Jul-2020	18:43:00	467982	5612841	ULL-CAM15		2	TF		
		12-Jul-2020	04:45:00	467982	5612841	ULL-CAM15		2	TF		
		16-Jul-2020	20:40:00	467982	5612841	ULL-CAM15		1	TF		

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 3. Continued.

Species		Date	Time	UTM Coordinates (10U)		Location	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing						
Mule Deer	*Ursus americanus*	17-Jun-2020	18:22:00	467982	5612841	ULL-CAM15		1	TF	M	Adult
		18-Jun-2020	02:54:00	467982	5612841	ULL-CAM15		1	TF		
		19-Jun-2020	08:33:00	467982	5612841	ULL-CAM15		1	TF		
		20-Jun-2020	04:42:00	467982	5612841	ULL-CAM15		1	TF		
		21-Jun-2020	22:22:00	467982	5612841	ULL-CAM15		1	TF		
		24-Jun-2020	05:27:00	467982	5612841	ULL-CAM15		1	TF		
		25-Jun-2020	10:32:00	467982	5612841	ULL-CAM15		2	TF		
		26-Jun-2020	09:38:00	467982	5612841	ULL-CAM15		1	TF		
		30-Jun-2020	08:38:00	467982	5612841	ULL-CAM15		1	TF		
		3-Jul-2020	02:47:00	467982	5612841	ULL-CAM15		1	TF		
		4-Jul-2020	06:06:00	467982	5612841	ULL-CAM15		3	TF		
		5-Jul-2020	00:24:00	467982	5612841	ULL-CAM15		1	TF		
		6-Jul-2020	09:58:00	467982	5612841	ULL-CAM15		1	TF		
		8-Jul-2020	18:43:00	467982	5612841	ULL-CAM15		2	TF		
		12-Jul-2020	04:45:00	467982	5612841	ULL-CAM15		2	TF		
		16-Jul-2020	20:40:00	467982	5612841	ULL-CAM15		1	TF		
		17-Jul-2020	12:06:00	467982	5612841	ULL-CAM15		2	TF		
		21-Jul-2020	19:55:00	467982	5612841	ULL-CAM15		3	TF		
		26-Jul-2020	08:45:00	467982	5612841	ULL-CAM15		2	TF		
		29-Jul-2020	00:06:00	467982	5612841	ULL-CAM15		1	TF		
		30-Jul-2020	06:14:00	467982	5612841	ULL-CAM15		1	TF		
		31-Jul-2020	07:35:00	467982	5612841	ULL-CAM15		1	TF		
		1-Aug-2020	23:03:00	467982	5612841	ULL-CAM15		1	TF		
		2-Aug-2020	01:38:00	467982	5612841	ULL-CAM15		1	TF		
		3-Aug-2020	02:20:00	467982	5612841	ULL-CAM15		1	TF		
		9-Aug-2020	06:43:00	467982	5612841	ULL-CAM15		2	TF		
		13-Aug-2020	05:10:00	467982	5612841	ULL-CAM15		1	TF		
		16-Aug-2020	04:42:00	467982	5612841	ULL-CAM15		2	TF		
		23-Aug-2020	07:56:00	467982	5612841	ULL-CAM15		2	TF		
		24-Aug-2020	01:40:00	467982	5612841	ULL-CAM15		1	TF		
		27-Aug-2020	09:12:00	467982	5612841	ULL-CAM15		2	TF		

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Table 3. Continued.

Species		Date	Time	UTM Coordinates (10U)		Location	Comments	Number	Activity[1]	Sex	Age
Common Name	Scientific Name			Easting	Northing						
Mule Deer	*Ursus americanus*	28-Aug-2020	09:08:00	467982	5612841	ULL-CAM15		3	TF		
		29-Aug-2020	06:30:00	467982	5612841	ULL-CAM15		4	TF		
		30-Aug-2020	23:59:00	467982	5612841	ULL-CAM15		1	TF		
		31-Aug-2020	06:36:00	467982	5612841	ULL-CAM15		3	TF		
		2-Sep-2020	11:14:00	467982	5612841	ULL-CAM15		2	TF		
		5-Sep-2020	06:48:00	467982	5612841	ULL-CAM15		5	TF		
		6-Sep-2020	09:53:00	467982	5612841	ULL-CAM15		2	TF		
		8-Sep-2020	05:00:00	467982	5612841	ULL-CAM15		1	TF		
		13-Sep-2020	05:27:00	467982	5612841	ULL-CAM15		5	TF		
		14-Sep-2020	07:29:00	467982	5612841	ULL-CAM15		2	TF		
		16-Sep-2020	21:53:00	467982	5612841	ULL-CAM15		1	TF		
		5-Oct-2020	21:09:00	467982	5612841	ULL-CAM15		3	TF		
Squirrel		4-Mar-2020	02:57:00	467982	5612841	ULL-CAM15		1	TF		
		21-Mar-2020	07:34:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		23-Mar-2020	08:12:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		2-Apr-2020	14:41:00	467982	5612841	ULL-CAM15		1	TF	U	Adult
		7-Apr-2020	13:53:00	467946	5613055	ULL-CAM02		1	TF	U	Unknown

[1]Activity Codes - AL: alert, BA: basking, BE: bedding, BI: birthing, BP: body parts, BU: building nest, CO: courtship, CR: carcass, DE: denning, DI: disturbed, FD: feeding, EX: excreting, FL: fleeing, GR: grooming, HI: hibernating, HU: hunting, IN: incubating, LI: unspecified, RR: rearing, ST: security/thermal, TE: territoriality (singing), TF: traveling, flying, UR: urinating

Appendix K. Grizzly Bear, Moose and Mule Deer Habitat Along the Transmission Line

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. ULH-MAMCM01

Figure 1. Vegetated screen along the transmission line at ULH-MAMCM01, assessed on June 14, 2018.

Figure 2. Vegetated screen along the transmission line at ULH-MAMCM01, assessed on August 24, 2020.

Table 1. Vegetated screen monitoring summary at ULH-MAMCM01.

General comment:	This site is disturbed and partially burnt. Some trees that were ~2-3 m in height in 2018 and were expected to reach 5 m in height were cut down. Some natural regeneration is apparent, but vegetation is slow to recover from the Boulder Creek forest fire. Further monitoring is recommended.
Species:	Grizzly Bear
Screen widths (m):	12, 5, 5
Average screen width (m):	7
Screen heights (m):	6, 4, 3
Average screen height (m):	4
% Screen coverages:	10, 20, 20
Average % screen coverage:	17

2. ULH-MAMCM02

Figure 3. Vegetated screen along the transmission line at ULH-MAMCM02 (at the top of the hill in the photo), assessed on June 14, 2018.

Figure 4. Vegetated screen along the transmission line at ULH-MAMCM02 (at the top of the hill in the photo), assessed on August 24, 2020.

Table 2. Vegetated screen monitoring summary at ULH-MAMCM02. Note that the screen could not be measured due to height of the site above the road.

General comment:	This site is very high above the road. Vegetation is slow to recover from the Boulder Creek fire. Further (qualitative) monitoring is recommended.
Species:	Grizzly Bear
Average screen width (m):	-
Average screen height (m):	-
Average % coverage:	-

3. ULH-MAMCM04B

Figure 5. Vegetated screen along the transmission line at ULH-MAMCM04B (river right of the creek), assessed on June 14, 2018.

Figure 6. Vegetated screen along the transmission line at ULH-MAMCM04B (river right of the creek), assessed on August 24, 2020.

Table 3. Vegetated screen monitoring summary at ULH-MAMCM04B.

General comment:	Moderate natural regeneration, with limited growth on the wood chips. Planting is recommended in areas where growth is restricted by wood chips as little revegetation progress has been observed after two years. Further monitoring is recommended.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	5, 2, 3
Average screen width (m):	3
Screen heights (m):	1, 3, 1
Average screen height (m):	2
% Screen coverages:	5, 20, 10,
Average % screen coverage:	12

4. ULH-MAMCM06

Figure 7. Vegetated screen along the transmission line at ULH-MAMCM06, assessed on June 14, 2018.

Figure 8. Vegetated screen along the transmission line at ULH-MAMCM06, assessed on August 24, 2020.

Table 4. Vegetated screen monitoring summary at ULH-MAMCM06.

General comment:	Dense natural regeneration of shrubs, vegetation is expected to reach heights greater than 5 m within 1 to 2 years. Further monitoring is recommended.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	20, 20, 15
Average screen width (m):	18
Screen heights (m):	5, 5, 3
Average screen height (m):	4
% Screen coverages:	80, 70, 60
Average % screen coverage:	70

5. ULH-MAMCM07

Figure 9. Vegetated screen along the transmission line at ULH-MAMCM07, assessed on June 14, 2018.

Figure 10. Vegetated screen along the transmission line at ULH-MAMCM07, assessed on August 24, 2020.

Table 5. Vegetated screen monitoring summary at ULH-MAMCM07.

General comment:	Some regeneration of shrubs observed along the road and vegetation is expected to reach 5 m in height within 2 years. However, there is limited regeneration on the 70 m wide scree slope. A large gap in the screen remains here, but planting would not be feasible due to the substrate. Further monitoring is not recommended.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	2, 3, 5
Average screen width (m):	3
Screen heights (m):	3, 2, 2
Average screen height (m):	2
% Screen coverages:	20, 10, 5
Average % screen coverage:	12

h. ULH-MAMCM08

Figure 11. Vegetated screen along the transmission line at ULH-MAMCM08, assessed on June 14, 2018.

Figure 12. Vegetated screen along the transmission line at ULH-MAMCM08, assessed on August 24, 2020.

Table 6. Vegetated screen monitoring summary at ULH-MAMCM08.

General comment:	Abundant dense vegetation continues to regenerate naturally. Vegetation is expected to reach 5 m in height within 1 to 2 years. Further monitoring is recommended.
Species:	Mule Deer
Screen widths (m):	15, 20, 15
Average screen width (m):	17
Screen heights (m):	5, 4, 3
Average screen height (m):	4
% Screen coverages:	30, 80, 40
Average % screen coverage:	50

7 ULH-MAMCM09

Figure 13. Vegetated screen along the transmission line at ULH-MAMCM09, assessed on June 14, 2018.

Figure 14. Vegetated screen along the transmission line at ULH-MAMCM09, assessed on August 24, 2020.

Table 7. Vegetated screen monitoring summary at ULH-MAMCM09.

General comment:	Some vegetation has grown tall, but there is limited growth in rocky areas. Height and coverage have increased somewhat since 2018 and planting is therefore not recommended at this time; however, this should be reassessed in Year 5. Overall, vegetation is on track for reaching 5 m in height. Further monitoring is recommended.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	5, 5, 1.5
Average screen width (m):	4
Screen heights (m):	4, 1.5, 1
Average screen height (m):	2
% Screen coverages:	5, 10, 3
Average % screen coverage:	6

8. ULH-MAMCM10

Figure 15. Vegetated screen along the transmission line at ULH-MAMCM10, assessed on June 14, 2018.

Figure 16. Vegetated screen along the transmission line at ULH-MAMCM10, assessed on August 24, 2020.

Table 8. Vegetated screen monitoring summary at ULH-MAMCM10.

General comment:	Good natural regeneration. Vegetation is expected to fill in and reach heights of 5 m within 2 years. Further monitoring is recommended.
Species:	Mule Deer
Screen widths (m):	10, 12, 10
Average screen width (m):	11
Screen heights (m):	3, 2, 1
Average screen height (m):	2
% Screen coverages:	10, 15, 20
Average % screen coverage:	15

9. ULH-MAMCM11

Figure 17. Vegetated screen along the transmission line at ULH-MAMCM11, assessed on June 14, 2018.

Figure 18. Vegetated screen along the transmission line at ULH-MAMCM11, assessed on August 24, 2020.

Table 9. Vegetated screen monitoring summary at ULH-MAMCM11.

General comment:	Abundant regeneration of red alder along the road that are ~7 m in height. Some brush cutting observed under the powerlines.
Species:	Mule Deer
Screen widths (m):	12, 10, 10
Average screen width (m):	11
Screen heights (m):	5, 7, 3
Average screen height (m):	5
% Screen coverages:	60, 40, 50
Average % screen coverage:	50

iii. ULH-MAMCM12

Figure 19. Vegetated screen along the transmission line at ULH-MAMCM12, assessed on June 14, 2018.

Figure 20. Vegetated screen along the transmission line at ULH-MAMCM12, assessed on August 24, 2020.

Table 10. Vegetated screen monitoring summary at ULH-MAMCM12.

General comment:	This site has been disturbed; many alders and willows were cut down that had been expected to fill in and increase in size beyond the 5 m height requirement. However, natural revegetation is anticipated. Further monitoring is recommended.
Species:	Moose
Screen widths (m):	10, 5, 5
Average screen width (m):	7
Screen heights (m):	2, 1, 1.5
Average screen height (m):	2
% Screen coverages:	10, 10, 10
Average % screen coverage:	10

11. ULH-MAMCM14

Figure 21. Vegetated screen along the transmission line at ULH-MAMCM14, assessed on June 6, 2018.

Figure 22. Vegetated screen along the transmission line at ULH-MAMCM14, assessed on August 24, 2020.

Table 11. Vegetated screen monitoring summary at ULH-MAMCM14.

General comment:	Abundant natural regeneration with dense bushes. Vegetation is expected to grow taller than 5 m within 1 to 2 years. Further monitoring is recommended.
Species:	Grizzly Bear and Moose
Road deactivated:	Yes
Screen widths (m):	12, 12, 7
Average screen width (m):	10
Screen heights (m):	5, 5, 2,
Average screen height (m):	4
% Screen coverages:	100, 100, 100
Average % screen coverage:	100

12. ULH-MAMCM17

Figure 23. Vegetated screen along the transmission line at ULH-MAMCM17, assessed on June 6, 2018.

Figure 24. Vegetated screen along the transmission line at ULH-MAMCM17, assessed on August 24, 2020.

Table 12. Vegetated screen monitoring summary at ULH-MAMCM17.

General comment:	Moderate natural regeneration on river right of the creek in areas previously disturbed by Squamish Mills. Vegetation growth throughout the site is expected to reach 5 m height requirements within 1 to 2 years. Further monitoring is recommended.
Species:	Grizzly Bear
Screen widths (m):	10, 10, 5
Average screen width (m):	8
Screen heights (m):	5, 4, 3
Average screen height (m):	4
% Screen coverages:	100, 90, 80
Average % screen coverage:	90

13. ULH-MAMCM18

Figure 25. Vegetated screen along the transmission line at ULH-MAMCM18, assessed on June 6, 2018.

Figure 26. Vegetated screen along the transmission line at ULH-MAMCM18, assessed on August 24, 2020.

Table 13. Vegetated screen monitoring summary at ULH-MAMCM18.

General comment:	Excellent natural regeneration of willow and Black Cottonwood. There is a small gap in the screen adjacent to the old road.
Species:	Grizzly Bear
Screen widths (m):	25, 25, 20
Average screen width (m):	23
Screen heights (m):	5, 3, 6
Average screen height (m):	5
% Screen coverages:	90, 50, 40
Average % screen coverage:	60

14. ULH-MAMCM19

Figure 27. Vegetated screen along the transmission line at ULH-MAMCM19, assessed on June 6, 2018.

Figure 28. Vegetated screen along the transmission line at ULH-MAMCM19, assessed on August 25, 2020.

Table 14. Vegetated screen monitoring summary at ULH-MAMCM19.

General comment:	The tower access road through the site appears to be active. Abundant natural regeneration; vegetation is expected to reach heights greater than 5 m within 1 to 2 years. Further monitoring is recommended.
Species:	Grizzly Bear
Screen widths (m):	20, 25, 30
Average screen width (m):	25
Screen heights (m):	6, 2, 5
Average screen height (m):	4
% Screen coverages:	70, 30, 5
Average % screen coverage:	35

15. ULH-MAMCM20

Figure 29. Vegetated screen along the transmission line at ULH-MAMCM20, assessed on June 19, 2018.

Figure 30. Vegetated screen along the transmission line at ULH-MAMCM20, assessed on August 25, 2020.

Table 15. Vegetated screen monitoring summary at ULH-MAMCM20.

General comment:	Excellent natural regeneration. Vegetation at this site has grown tall, meeting the 5 m height requirement. The screen is expected to reach 100% screen cover.
Species:	Mule Deer
Screen widths (m):	20, 30, 15
Average screen width (m):	22
Screen heights (m):	5, 7, 6
Average screen height (m):	6
% Screen coverages:	85, 60 ,50
Average % screen coverage:	65

16. ULH-MAMCM21

Figure 31. Vegetated screen along the transmission line at ULH-MAMCM21, assessed on June 19, 2018.

Figure 32. Vegetated screen along the transmission line at ULH-MAMCM21, assessed on August 25, 2020.

Table 16. Vegetated screen monitoring summary at ULH-MAMCM21.

General comment:	This site is noticeably disturbed. Trees that were ~2-3 m in height in 2018 and were expected to reach 5 m in height were cut down. Screen coverage is low. However, natural revegetation is anticipated. Further monitoring is recommended.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	5, 5, 2
Average screen width (m):	4
Screen heights (m):	1, 1, 1.5
Average screen height (m):	1
% Screen coverages:	5, 2, 5
Average % screen coverage:	4

17. ULH-MAMCM22

Figure 33. Vegetated screen along the transmission line at ULH-MAMCM22, assessed on June 19, 2018.

Figure 34. Vegetated screen along the transmission line at ULH-MAMCM22, assessed on August 25, 2020.

Table 17. Vegetated screen monitoring summary at ULH-MAMCM22.

General comment:	This site is noticeably disturbed and transmission lines partially cross the road. All shrubs that were ~2-3 m in height in 2018 and were expected to reach 5 m in height were cut down. However, natural revegetation is anticipated. Further monitoring is recommended.
Species:	Grizzly Bear
Screen widths (m):	2, 8, 10
Average screen width (m):	7
Screen heights (m):	1, 1, 2
Average screen height (m):	1
% Screen coverages:	5, 2, 2
Average % screen coverage:	3

18. ULH-MAMCM23

Figure 35. Vegetated screen along the transmission line at ULH-MAMCM23, assessed on June 19, 2018.

Figure 36. Vegetated screen along the transmission line at ULH-MAMCM23, assessed on August 25, 2020.

Table 18. Vegetated screen monitoring summary at ULH-MAMCM23.

General comment:	Minimal screen height, vegetation composed primarily of abundant ferns and thimbleberry. Some alders, willows and cottonwood are regenerating. Wood chips may be restricting growth; however, alders, willow, and cottonwood are expected to fill in naturally and grow taller than 5 m over time. Further monitoring is recommended.
Species:	Grizzly Bear
Screen widths (m):	4, 10, 10
Average screen width (m):	8
Screen heights (m):	2, 1, 1
Average screen height (m):	1
% Screen coverages:	5, 5, 1
Average % screen coverage:	4

19. ULH-MAMCM24

Figure 37. Vegetated screen along the transmission line at ULH-MAMCM24, assessed on June 19, 2018.

Figure 38. Vegetated screen along the transmission line at ULH-MAMCM24, assessed on August 25, 2020.

Table 19. Vegetated screen monitoring summary at ULH-MAMCM24.

General comment:	Moderate regeneration along the road composed mostly of abundant thimbleberry. Some willow and alder regenerating; thus vegetation is expected to increase in height to 5 m, but the overall height will be limited by transmission line maintenance. Wood chips may be restricting growth. Further monitoring is recommended.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	8, 10, 6
Average screen width (m):	8
Screen heights (m):	1, 1.5, 1.5
Average screen height (m):	1
% Screen coverages:	5, 5, 10
Average % screen coverage:	7

20. ULH-MAMCM25

Figure 39. Vegetated screen along the transmission line at ULH-MAMCM25, assessed on June 19, 2018.

Figure 40. Vegetated screen along the transmission line at ULH-MAMCM25, assessed on August 25, 2020.

Table 20. Vegetated screen monitoring summary at ULH-MAMCM25.

General comment:	Excellent regeneration, screen height and width requirements have been met and cover is high.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	20, 25, 10
Average screen width (m):	15
Screen heights (m):	5, 7, 3
Average screen height (m):	5
% Screen coverages:	100, 90, 80
Average % screen coverage:	90

21. ULH-MAMCM26

Figure 41. Vegetated screen along the transmission line at ULH-MAMCM26, assessed on June 19, 2018.

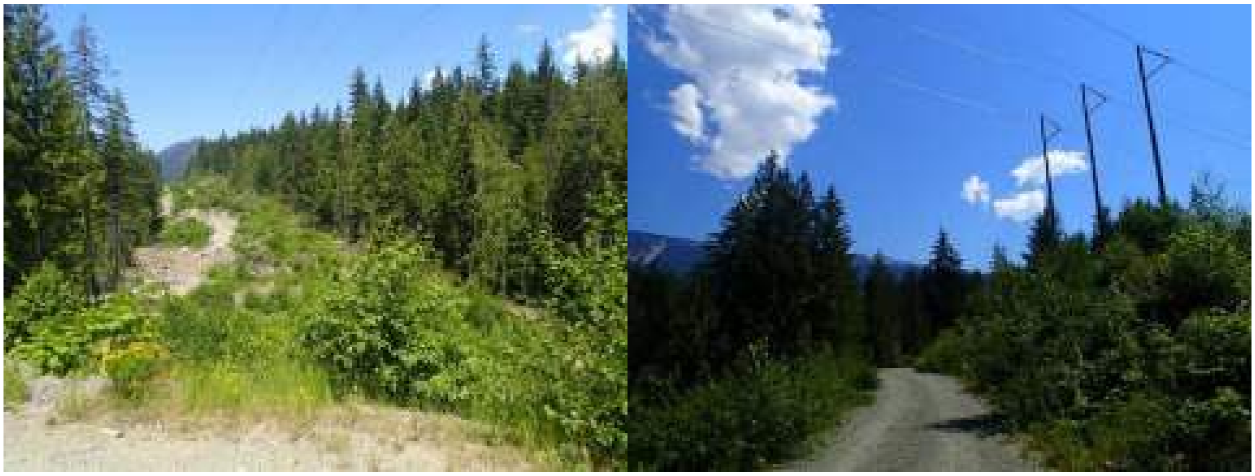


Figure 42. Vegetated screen along the transmission line at ULH-MAMCM26, assessed on August 25, 2020.

Table 21. Vegetated screen monitoring summary at ULH-MAMCM26.

General comment:	Transmission line crosses the road. Natural regeneration has resulted in successful filling in of the vegetated screen on the right side of the road. There has been some cutting on the left side. The site is on track and vegetation is expected to fill in and grow taller than 5 m within 1 to 2 years. Further monitoring is recommended.
Species:	Grizzly Bear and Mule Deer
Screen widths (m):	40, 45, 40
Average screen width (m):	42
Screen heights (m):	5, 2, 1
Average screen height (m):	3
% Screen coverages:	50, 45, 60
Average % screen coverage:	52

22. ULH-MAMCM27

Figure 43. Vegetated screen along the transmission line at ULH-MAMCM27, assessed on June 21, 2018.

Figure 44. Vegetated screen along the transmission line at ULH-MAMCM27, assessed on August 25, 2020.

Table 22. Vegetated screen monitoring summary at ULH-MAMCM27.

General comment:	Abundant natural regeneration; good mix of conifers and deciduous trees. The screen is expected to grow taller than 5 m within 1 to 2 years. Further monitoring is recommended.
Species:	Grizzly Bear
Screen widths (m):	60, 50, 30
Average screen width (m):	47
Screen heights (m):	5, 4, 3
Average screen height (m):	4
% Screen coverages:	95, 90, 85
Average % screen coverage:	90

23. ULH-MAMCM28

Figure 45. Vegetated screen along the transmission line at ULH-MAMCM28, assessed on June 21, 2018.

Figure 46. Vegetated screen along the transmission line at ULH-MAMCM28, assessed on August 25, 2020.

Table 23. Vegetated screen monitoring summary at ULH-MAMCM28.

General comment:	Abundant natural regeneration. Vegetation is expected to reach heights taller than 5 m within 1 to 2 years. Further monitoring is recommended.
Species:	Grizzly Bear
Screen widths (m):	50, 40 ,30
Average screen width (m):	40
Screen heights (m):	1.5, 5, 2
Average screen height (m):	3
% Screen coverages:	15, 20, 40
Average % screen coverage:	25